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Two 27-E Pavers Working Outside the Forms Pouring 20 Ft. Width of 40 Ft. Reinforced Concrete Trunk Highway in Santa Clara County, California, for the California State Highway Department. In Center Background Is the New Sunnyvale Airship Dock.

TWIN PAVERS

Make Progress Records on Concrete Paving Projects

By JAMES S. BURCH

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POURING 1451 cu. yd. of concrete pavement in 12 hours; 1537 cu. yd. in less than 13½ hours; and paving at that rate day after day;—those are the records being made by Basich Bros. of Torrance, Calif., in paving a section of the Bayshore Highway alongside the new Sunnyvale Airport in Santa Clara County for the California State Highway Department. In terms of the 10 in.-8 in.-10 in. section used on this project, 1453 cu. yd. represents 2761 lin. feet 20-ft. wide in a 12-hour day; and is equivalent to 3215 lin. feet of the usual 9 in.-7 in.-9 in. section 20 feet wide.

Although as high as 137 cu. yd. of pavement concrete have been poured per hour on a transit mixer job where each truck is in reality a mixer, the above 120 cu. yd. per hour maintained for 12 hours is considered an all time record for two-paver operation.

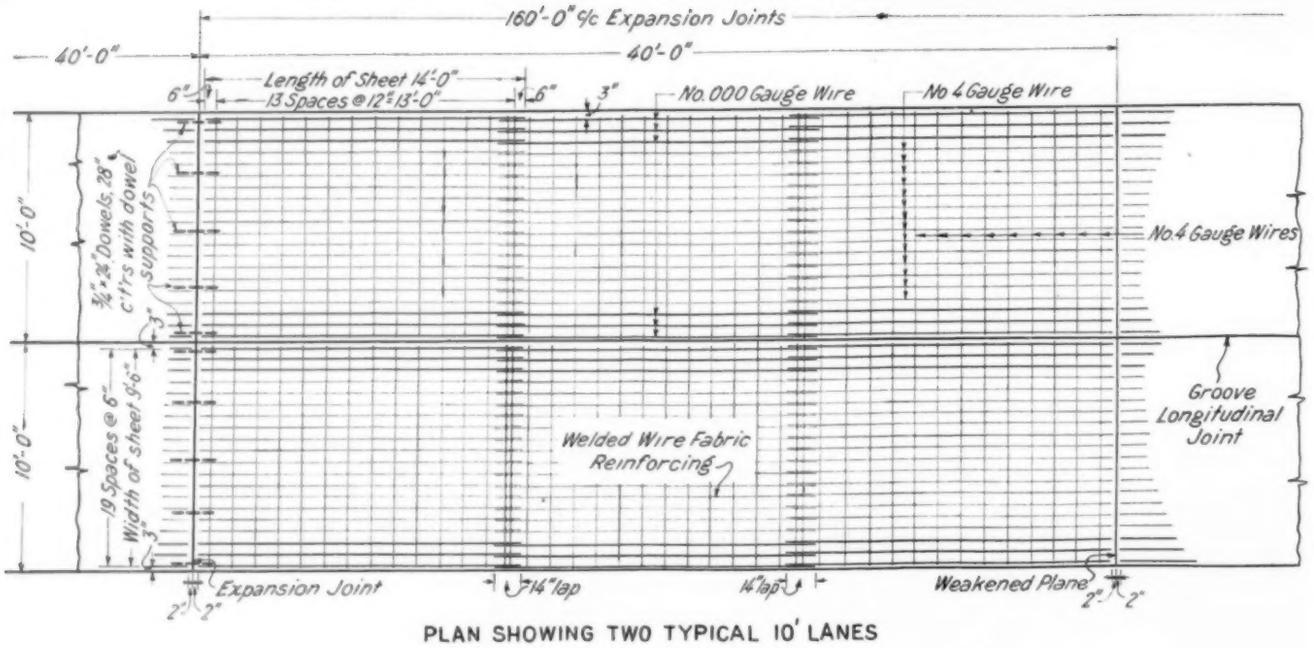
Delayed first by bad weather, and then being forced to complete the major portion of the contract prior to the official opening of the Naval Airport for dirigibles at Sunnyvale, where the Macon will soon be berthed, the contractor set up a progress schedule requiring maximum daily output. The 30-hour work week requirement was overcome by working two complete paving crews 5 or 6 hours per day each. Although the contract is not yet complete, it is evident that even the fast paving schedule set will be met without serious trouble.

This project involved grading and paving a section of the Bayshore Highway south of Palo Alto for a length of about 3½ miles alongside the Sunnyvale Airport. The graded width of 60 ft. is being paved with a 40-ft. width of 10-8-10 concrete reinforced throughout with 58 lb. welded wire fabric. This California State Highway project, 1st in November, 1932, and known as No. IV S.Cl.—68 A & B, involved about 6,000 cu. yd. of excavation, 67,000 cu. yd. of borrow, 19,350 cu. yd. of pavement concrete and 412,000 lbs. of welded wire fabric reinforcement. An adjacent project about 4.7 miles long of similar cross section was built simultaneously by the same contractor with the same equipment.

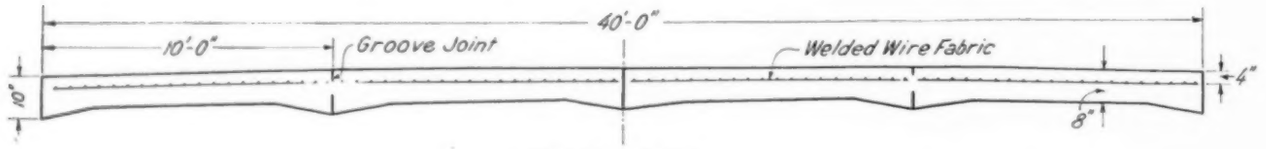
Grading.—The project was built on a new location across flat black adobe clay fields and the bulk of the earthwork consisted of hauling in gravel borrow from a pit some 3½ miles from the project. This borrow was excavated by a 2½ cu. yd. Northeast dragline and loaded directly from the drag bucket into 6-wheel trucks; from 20 to 45 trucks being used to handle about 4500 cu. yd. of borrow per day of 18 hours in three 6-hour shifts.

An Ateco bulldozer on a Caterpillar "65" spread the material, together with an Ateco scraper followed by a 12-ft. sheepsfoot roller. Since much of this work was done after dark, the contractor used a Kohler lighting plant mounted on an old auto chassis. The gravel subgrade fill was from 13 to 48 in. deep, 60 ft. wide between shoulder lines, and was placed and rolled in layers. Grading involved in this and the companion contract involved about 227,000 cu. yd. of borrow, this work being started on Dec. 5th, 1932, and completed on March 10th, 1933.

Paving.—The water for mixing pavement concrete was obtained from local irrigation wells, and was stored in a large local reservoir. The water was pumped from the reservoir into the mixer line with an Aldrich 250 gal. 300 lb. triplex pump run by a 50 h.p. electric motor at



PLAN SHOWING TWO TYPICAL 10' LANES



CROSS SECTION

Details of Reinforcement for Two Typical 10 Ft. Lanes

a pressure of 250 to 300 lb. The pipe line was 4-in. seamless steel tubing in 37-ft. lengths, asphalt coated, connected with special leak proof gasket and clamp couplings, with 1½-in. faucets placed at each fifth coupling.

The subgrade was roughly prepared with a Russell 12-ft. blade grader pulled by a Caterpillar "60." Paving forms or headers were 3 in. by 11 in. Oregon pine set with 2-in. x 4-in. x 21-in. diagonal cut pine stakes driven 4 ft. apart. These forms were surfaced with ⅝-in. x 2½-in. steel caps to protect the header edges under the finishing machine wheels. From 4500 to 5000 lin. ft. of forms were set daily and this work was maintained about one mile ahead of the paving. A 30-h.p. Caterpillar pulled a Johnson subgrade scarifier and a Lakewood subgrader in finishing the subgrading, tailings being thrown out by hand to conform with Government requirements. The subgrade was rolled with a 4-cylinder gas Austin 3-wheel 12-ton roller.

On the companion project, which was reinforced with only a double line of marginal bars, 10 men were required to set the steel in place. On this project where welded wire fabric was used, no marginal bars were employed, and, hence the above 10 laborers were not needed. A submerged longitudinal joint of ¾-in. x 5½-in. redwood was staked in vertically to divide the pavement into 10-ft. lanes;—the paving being done in 20-ft. widths. Transverse expansion joints of sponge rubber, together with sleeved steel dowels, were spaced 120 ft. apart on the bar reinforced section and 160 ft. apart on this project reinforced with welded wire fabric.

For a short length, as an experiment in controlling the moisture content in the subgrade, and resisting the entrance of surface water, the subgrade was given a surface treatment of ½ gal. of 95 plus asphaltic road oil. This oil was spread hot with a Spears-Wells distributor in 10-ft. widths and covered with sand by hand shovels.

Materials.—Concrete aggregates used were coarse pit sand and two sizes of gravel, the large size being 3 in. to 1½ in. Aggregates were furnished by the Kaiser Paving Co. from a gravel pit near Livermire, 30 miles from the paving project. A special Southern Pacific train and crew was employed full time to supply the job and shift loaded and empty cars on the siding. From 45 to 55 cars of aggregate were used per day.

Welded wire fabric reinforcement was furnished by the Soule Steel Co. of San Francisco, being hauled to the job partly by rail and partly by truck. This reinforcement was furnished in flat sheets 14 ft. long and 9 ft. 6 in. wide and could be easily distributed along the form line by a truck and two men. The details of the reinforcement may be noted in the accompanying diagram.

The cement came direct by truck from the Pacific Portland Cement Co.'s plant at Redwood City. Six-wheel Mack trucks with one 6-wheel trailer attached brought about 450 bags per trip, the cement being unloaded directly onto the batch trucks without stockpiling or storage.

Proportioning Plant.—A very efficient conveyor belt weigh-batching plant was used, handling about 50 cars of sand and gravel per day with only about six men working at the plant. Material was dumped from cars into a gravity pit and carried by a 30-in. conveyor belt up to storage bins. The material was accurately weighed in Johnson batch hoppers with scales and dropped onto a second conveyor belt which carried the measured batches to a revolving chute, and thence into three batch boxes mounted over the batch truck driveway.

Three-batch dual tired Reo trucks received the batches

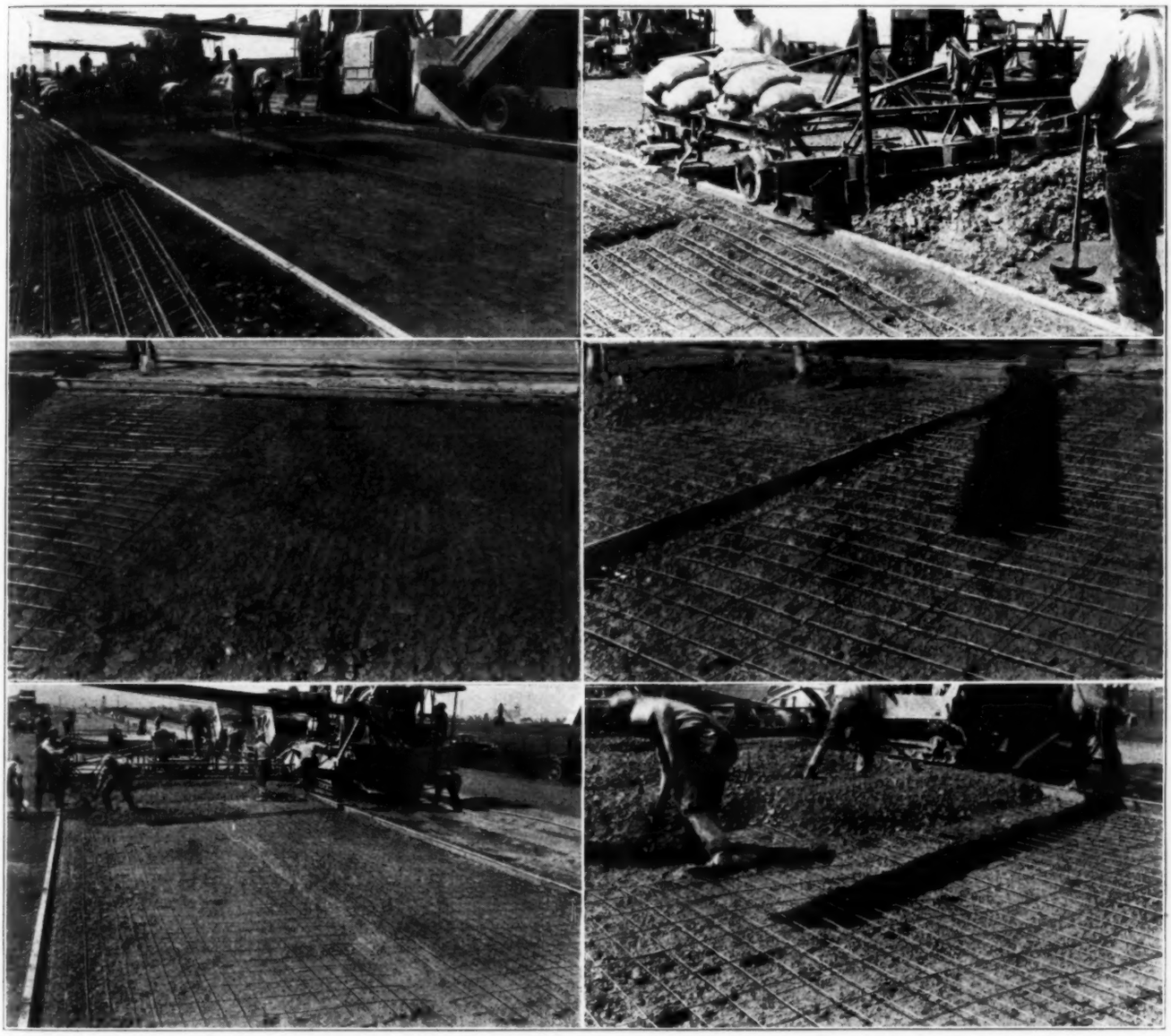
and hauled past the cement trucks, where 6 bags of cement were dumped on each batch, and proceeded to either of the two pavers. Enough trucks were provided so that at each paver there were two trucks at all times, one dumping and one standing. It is the belief of Superintendents Wilcox and Faw that the only way to pave is to keep "a batch in the skip and water in the glass" at all times.

Paving.—Two 27-E Ransome 1930 model pavers worked outside the forms about 25 to 50 feet apart. The pavers were not "in tandem," but each mixed batches for the full cycle and spread the concrete on the subgrade. To provide for possible delays in changing hose; each paver carried an auxiliary water tank holding enough water to mix 7 batches. Each mixer carried a 25-ft. boom and was equipped with an especially fast skip hoist and discharge chute.

The mixing time in the drum was 50 seconds according to the California State Highway requirements. Net charging lag on the two mixers was 10 and 11 seconds respectively; thus the maximum output was approximately 1 cu. yd. batch per minute per paver, or 120 cu. yd. per hour for both pavers together; this output representing 100 per cent production efficiency.

The same equipment had been working on the companion marginal bar reinforced project, wherein bars were set well ahead of paving, and remarkable speed records had been made. On one day 100 per cent output of 120 batches per hour for 10 hours was made. In fact for 12 consecutive days an average of 111 cu. yd. per hour, or 92.5 per cent efficiency, had been accomplished.

It was feared by the contractor that the installation of the wire fabric reinforcement would tend to delay the



Upper Left: Subgrade Ready; Submerged Longitudinal Plane of Weakness Joint Strip in Place. Reinforcement Shown on Shoulder Is Not Installed Until Struck Concrete Bed Had Been Prepared. Three Inch Wood Forms Capped with 5/8 In. Steel Strips. Upper Right: Old Finishing Machine Equipped with Adjustable Strike-Off Plate Mounted on Screed Board Strikes Off Concrete to Proper Elevation Prior to Laying in Fabric Sheets. Sand Bags Used to Improve Rear Wheel Traction. Middle Left: Level Bed of Struck Concrete Ready for Laying in 14 Ft. by 9 Ft. 6 In. Sheets of Fabric Reinforcement. Two Men Handled Fabric Installation, Laps Being Made Without Ties, Clips or Pins. Middle Right: Transverse Expansion Joint with Adjacent Fabric Sheets in Place on Struck Concrete Bed, Preparatory to Placing Patches of Upper Concrete. Walking on Reinforcement Was Not Objectionable. Lower Left: Ample Working Space Between Pavers, Which Were Normally 25 to 50 Feet Apart, Permitted Fabric Placement and Spreading of Upper Concrete Patches by the Second Paver. Lower Right: Spreading Concrete Ahead of Finishing Machine. Although Concrete of Rather Stiff Consistency Was Used Throughout, This Machine Screeded Twice Over at the Rate of 235 Lin. Ft. per Hour Without Crowding.

progress of the job. This fear was predicated on the usual supposition that the time required to strike off the concrete to support the fabric sheets and to install the sheets would serve to delay paving progress.

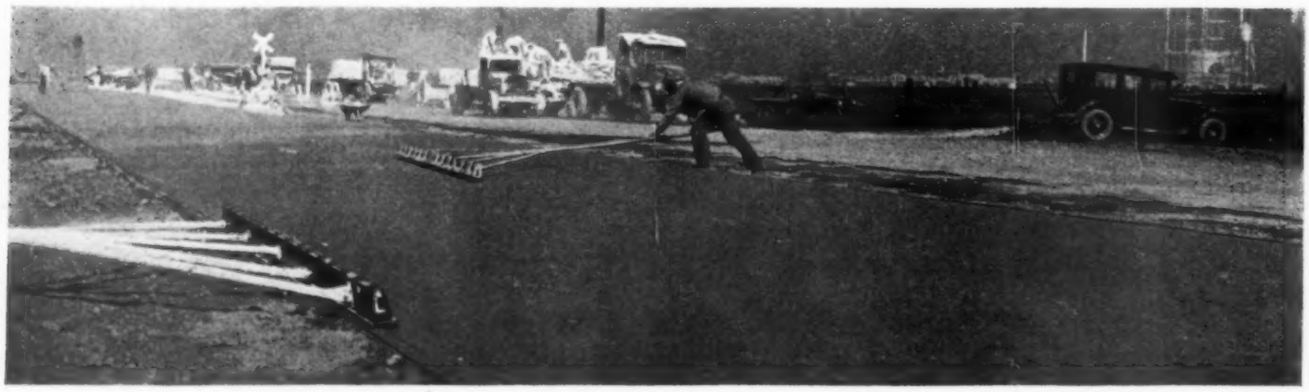
The state highway department had previously used welded wire fabric reinforcement where the paving was done by a single paver pouring in 10-foot lanes. It had been found that on such construction, the installation of the fabric sheets did not necessarily cause delay in paving progress. This particular project was set up for the fastest possible two-paver output, with paving being done in 20-foot widths. It was felt, therefore, that fabric use would be more liable to delay such a high speed job, than a job operating at a slower output; and similarly, it was considered that if fabric use did not delay production on this particular project, then its use should not tend to delay progress on any paving job. By reason of the adjacent marginal bar reinforced project of

TABLE I—DAILY PAVING PROGRESS ON FABRIC REINFORCED JOB

Date	Lineal Ft., 20 Ft. Wide	Cu. Yds.	Hours	Cu. Yds. per Hr.	% Max. Output
April 8.....	2130	1109	10	111	92.5*
April 10.....	2600	1345	11½	117	97.5
April 11.....	1480	767	7	110	91.7
April 12.....	2761	1451	12	120	100.0
April 13.....	2240	1165	12	97	81.0
April 14.....	640	332	3	111	92.5
April 15.....	2920	1537	13½	114	95.1
April 17.....	2640	1382	12	115	96.0
April 18.....	1320	689	6	115	96.0
Total	....	9777	87	112.4	93.8†

*Includes start on new section, intersection and equipment delays.

†Includes all delays occurring within the various daily runs.



After a Delayed Finish by Another Machine, the Surface Was Floated, Broomed, Straight-Edged and Cured with Burlap and Wet Earth. A Daily Run of 2800 Feet Was Not Unusual.

similar cross section being built simultaneously by the same contractor, there was offered a most excellent opportunity to observe the relative production speeds as influenced by the two types of reinforcement.

The writer visited this project just prior to the beginning of work on the fabric reinforced section and observed in detail the facility with which the work was being executed; remaining on the job for several days. Paving was started on the fabric reinforced project on April 8th.

On the first paving day on this project, 1109 cu. yd. were poured in 10 hours, in spite of numerous minor equipment delays and the paving of an intersection with a dry high early strength mix. Even including these delays the output for the day was 92.5 per cent of maximum possible output. Succeeding days showed equal and better progress, including the all time two-paver records described in the first paragraph of this article. Thus it became evident at the outset that the use of fabric reinforcement caused no delay whatever.

Table 1 shows daily progress on this project for the first nine paving days on fabric. It will be noted that, including all delays of all kinds, the output over this period averaged 112.4 cu. yd. per working hour or 93.8 per cent of maximum possible paver output. Even the fast progress on the marginal bar section of 111 cu. yd. per hour was exceeded on this project at the outset.

Detailed Paving Procedure.—The first mixer deposited full cubic yard batches on the subgrade to about 6 in.-4 in.-6 in. depth section and moved ahead. This course was struck off at the proper elevation 4 in. below pavement surface by means of a strike-off plate mounted on the screed board of an old Lakewood finishing machine, a veteran of many hundred thousand yards of pavement. This plate was of ½-in. steel on a hinged mounting for raising up over expansion joints, and was equipped with adjusting wheels so that its height above subgrade could be closely controlled, thus balancing the "pull" of the two pavers. Since all the weight was on the front of the machine, a number of sand bags were used over the rear wheels to improve the traction. This machine did nothing but make the strike-off, with the aid of 3 men spreading, leaving an even firm bed for the placing of the reinforcement.

Sheets of welded wire fabric reinforcement 14 ft. by 9 ft. 6 in. and weighing about 78 lbs. each were easily laid in position by two men. The end laps were made without ties, clips or pins, the sheets laying flat in proper position. Walking on the fabric in place was not harmful, since it was stiff enough to resist bending and displacement.

The second mixer, working from 25 to 50 ft. behind the first, deposited full cubic yard batches on the fabric reinforcement; not over 7 or 8 minutes intervening between the pouring of the lower and upper courses of concrete, the mix in each course being identical. About eight spreaders and side spaders worked the concrete ahead of a Lakewood single screed and tamper finishing machine which also carried a cutting wheel to form the longitudinal joint groove. This machine exhibited remarkable performance in screeding twice over at the rate of as high as 235 lin. ft. of 20-ft. width pavement per hour, requiring a forward speed of 12½ ft. per minute.

Following this double screeding, longitudinal joint steel strips were laid in the groove, transverse groove joints were formed, and sawtooth expansion joint plates were replaced by thin channel caps. The final delayed surface screeding was done by an Ord double screed finishing

machine carrying only an inch or two of mortar; this machine also covering the surface twice.

Screeding was followed by the longitudinal float operated from bridges and by four adjustable 16-ft. wood batten floats operated from the shoulders by means of long handles. After edging sides and joints, straightedging the surface and brooming with a special 20-ft. broom mounted on wheels on the forms, the surface was again checked and covered with wet burlap for 24 hours, followed by earth and water for 10 days prior to opening to traffic.

To maintain the equipment in good working order the contractor maintained a corps of repair men, mechanics, and oilers who worked during the night to make all necessary repairs and adjustments. An observation of this job showed that the exceptional progress being made could be attributed primarily to three basic reasons; first, careful and accurate planning of organization and procedure based on many years of paving experience; second, good equipment of proper size, well handled and kept in good repair; and third, excellent supervision coupled with willing, hard working labor, all striving to obtain full yardage of excellent pavement each day.

Although the job is still under construction, and the final progress records have not been made, it is quite probable that phenomenal job averages will be created. One of the outstanding developments on this job was the determination that the use of welded wire fabric reinforcement created on delay whatever as compared to the design on the companion project which employed only marginal bars; or similarly, as compared to a job which contains no reinforcement whatever. The cost of the fabric reinforcement in place was practically the same per square yard of pavement as the cost of the marginal bar system of reinforcement; the fabric costing about 1.8 per cent less than the bar system. Likewise it was interesting to observe that no special equipment, with the single exception of the strike-off plate, was needed for the installation of the fabric reinforcement.

This project is being constructed for the California State Highway Department under C. H. Purcell, State Highway Engineer, C. S. Pope, State Construction Engineer, John H. Skeggs, Fourth District Engineer, and W. A. Rice, Resident Engineer. Representing Basich Bros., the contractors, are P. L. Wilcox, General Superintendent, and George Faw, job superintendent.

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Brick Pavement on Sand-Clay Base

A BRICK surface on a specially proportioned mixture of sand and clay as a base was constructed recently in a 5-mile road job in Dougherty County, Georgia. The work was described by John H. Lowe, County Engineer, in a paper presented at the 1933 annual meeting of the National Paving Brick Association. An abstract of Mr. Lowe's paper follows:

Rough Grading.—This job was along an old road and the road was not closed to traffic as it would have involved a long and objectionable detour. All fills were made in layers of not over 18 in. in depth and all material was hauled in trucks and over the freshly placed material. This gave us the benefit of our truck haul as well as the usual traffic on the road. The top 2 ft. of all fills were made of selected materials when necessary and in all cuts where doubtful material was encountered this was removed to a depth of 18 in. and replaced by selected material. All necessary drainage was placed and the finished grade of the road throughout was well above water line at all low places.

The stretch of road was open to traffic for more than a year and under all weather conditions and has held up well. Not a single failure occurred and very little inconvenience was caused the public.

The type of road finally selected was a brick on a sand-clay base 18 ft. between 5 by 12 headers. The brick were 2½ in. vertical fibre, vitrified brick, laid on a 6 in., when compacted, sand-clay base which had received a tar prime before a ¾ in. sand cushion had been placed. The spaces between the brick was filled with asphalt having a penetration of from 30 to 40.

The Sand-Clay Base.—Before starting the base numerous tests were made of both the clay and sand borrow pits; also many experiments were made with different mixtures of different known proportions of sand and clay, with the result that we finally settled on a mixture containing not less than 10 and not more than 13 per cent of clay.

The materials from the different borrow pits were placed on the road and measures by means of side boards and templates striking each material off at the proper depth to get the proportions desired. The sand was placed at the bottom. The materials were then mixed by plowing and harrowing until tests of the mixture showed a uniformity desired. In most cases the materials from the borrow pit contained sufficient moisture, but in cases where necessary water from a road sprinkler was added. The road was then brought to a true surface with a road machine or a motor patrol and left to the traffic.

We found that after the material had partially set and the surface dried out no machining could be done except immediately after a rain or after the whole surface had been thoroughly wetted by sprinkling. This precaution is necessary to prevent scabbing, which is thin laminations on the surface of the road.

The Concrete Headers.—After the base was completed and set up under traffic, the concrete headers were built to hold the brick at the outer edges of the road. These headers were built by using 3 by 6 in. dressed plank, spiked to the base, and 5 in. apart, with 12 in. round spikes. The planks were drilled for the spikes at about 8 ft. spacing. These planks were used over and over, being removed as soon as the concrete had set up.

After the 3 by 6 plank had been trued up to the correct height the material between them was removed with special spades to a depth of 12 in. below the top of the plank. The concrete was then poured, leaving contraction joints every 10 ft. and expansion joints every 100 ft.

The Sand Cushion.—After the headers had been completed the surface of the road was trued up to the proper depth and approximate crown of the finished surface of the brick, then the tar prime was applied in the usual manner and when time had been given for it to penetrate the sand cushion was placed. The sand used in the cushion contained about 5 per cent of clay. This was brought to a true surface about 1 in. thick by means of a template of the same crown as the finished road and then rolled with a light hand roller. It was then brought to a true surface with a template, truing it off to ⅜ in. in thickness.

Brick Paving.—On this sand-clay the brick were laid in the usual manner. After the brick were culled the surface was rolled with a 3-ton roller until the surface was true and no variation of more than ¼ in. in 10 ft. All spaces between brick were then immediately filled with asphalt and the surface covered lightly with sand.

The West Side Elevated Highway, New York City

THE unfavorable soil conditions which are found along the river front on the west side of Manhattan introduced an unusual engineering problem into the construction of the recently completed West Side elevated public highway from 22nd St. to 38th St., New York City. Despite the difficulties encountered in sinking 119,000 lin. ft. of piles, the contractors for both the foundations and the superstructure, Poirier & McClane Corporation, of New York, were able to complete the job one month ahead of schedule at a saving to the city of $1,147,471. The cost of the foundation work was $756,000 and of the superstructure $1,650,000.

Clifford M. Pinckney, Chief Engineer of Public Works for the Borough of Manhattan, was the designing engineer of the highway which was constructed as part of the public works program of Samuel Levy, Borough President, and H. Warren Hubbard, Commissioner of Public Works. The new section was opened to the public Jan. 5th by Mayor John P. O'Brien, giving the city a continuous elevated roadway from Canal St. to 38th St.

The estimated cost of the entire highway, from Canal St. to 72nd St., has been scaled down from the original $25,000,000 to $15,000,000. Plans are well advanced for the creation of new Twelfth Ave. between 48th and 59th St., which is being made necessary by the construction of the new 1,000 ft. piers in this vicinity. It is expected that the entire 4½ miles of elevated highway will be completed before Jan. 1st, 1934.

From an engineering standpoint, the foundation work was of particular interest. The proximity of the Hudson River and the fact that the land is filled-in were the complicating factors. Because of the heavy deposits of Hudson River silt, the piles had to be driven to rock, which was a depth of from 80 to 186 ft. below street level. Since much of the land was made, they encountered rock-filled cribs and hulls of sunken boats.

The piles consisted of 18-in. pipe with a ½-in. wall, and were driven in sections from 30 to 50 ft. long. The steel casting pile points used averaged approximately 140 lbs. in weight and were furnished by the Otis Elevator Co. Both points and pipe were driven by heavy pile driving rigs of the land type with 100 ft. leads. The hammer was a single acting steam hammer having striking parts of more than 5,000 lbs. falling not less than 36 in. by gravity.

Erecting Final Girder on Elevated Highway Superstructure at Junction of Old Structure

The number of piles sunk for each pier varied from five to nine, and the piers varied in size from 8 ft. 6 in. by 8 ft. to 10 ft. 6 in. by 10 ft. The piles, of which there were 971, were driven on centers of 2 ft. 6 in. and 3 ft. 6 in.

The superstructure, for which Poirier & McClane were also the contractors, was in accord with the best practice in this type of engineering. The 4,400 lin. ft. of highway is composed of independent frames, varying in length from 60 to 100 ft.

An interesting feature of the superstructure is the type of pin bearing castings provided on the top of each column for the girders to rest on. The steel pin housed in the casting has a recess into which is fitted the projection on the steel casting, thus creating a lateral fastening. These castings were also furnished by the Otis Elevator Co.

The roadway itself was built according to the specifications used on the first section of the highway, granite blocks over reinforced concrete bed. It has a transverse slope of 5 in. in 30 ft.

Between the frames the gaps are spanned by a cast steel road plate made by the Otis Elevator Co., which allows for a ¾ in. expansion. The plate lies flush with the roadway. Between the two 30-ft. roadways, and in the gutters at the sides, there are longitudinal troughs connected to downspouts at the columns. The drainage trough was made up of channels with cast steel tie plates and with cast steel gratings furnished by the Otis Elevator Co.

View of West Side Elevated Highway at 27th St., New York City

Social Factors in Development of Regional Highways

By W. RUSSELL TYLOR
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POPULATION and its mobility exemplified by the routes of communication are fundamental aspects of community life. The importance of the road in human affairs is well recognized. Jean Bruhnes in Human Geography[1] considers it first among his six primary categories. The increasing recognition of the need for social planning in its broader aspects makes even more pertinent a consideration of our projected thoroughfare routes as they will effect the structure and character of our community life and more particularly as they are revealed in the regional planning movement, since a comprehensive highway plan is the recognized skeletal basis of regional planning.

Factors Back of Present Highway Development.— Let us first, however, briefly glimpse the factors that lie back of our present highway development.[2] From the viewpoint of the historian and the sociologist the highways are most used part of the past in our present day material civilization. The tools, implements, clothes and general paraphernalia of the preceding centuries are museum pieces. A few buildings, it is true, survive, but the roads, by and large, which just happened to meet the requirements of those earlier days when footpaths, horseback and the stage coach were the dominant forms of travel, are still in every day use. Their surface has been improved, but the location, reflecting their original purpose when community life was comparatively simple, has largely remained unchanged.

The Indian trails and the buffalo traces which the early settlers found in this country were the sites of many of the first long distance roads. The Indians' choice of a trail was in turn motivated by the desires for seclusion, directness, and dryness. Thus topography from the very beginning has been an important factor in the location of a highway. Such considerations were later advantageous as determining the colonial military trails. There are many examples of Indian and military trails that have become highways. The Lincoln Highway between Pittsburgh and Chambersburg was first the Kittonning Trail, then the General Forbes' Road, next the Chambersburg Pike, while now it is a portion of

Bronx Parkway Extension, Milwood, Westchester County, New York

Footbridge Over Bronx River in Westchester County Development

the Lincoln Highway. Immigrant trails in turn became the foundations of many of the roads of the middle and far west. The Old National Road in the southern part of Illinois and the Santa Fe Trail are examples of this type of highway origin.

Throughout most of England the existing system of main highways owes its origin to the network of military roads constructed during the Roman occupation. The Way of the Pilgrims—which would correspond to our immigrant trails—and the early trade routes were likewise determining factors. Medieval routes were first evolved as bridle or pack-horse ways, and developed in the centuries immediately following as rough vehicular tracks. Some of these were later widened and improved into "turnpike" roads during the coaching era, while others remain as byeways to this day.[3]

The rectangular system of roads in America had its foundations in the practices followed in the development of the large land grants made in colonial Virginia. To determine the boundaries of a grant a river was usually selected to form the base. At right angles to this base river line and at intervals of a mile or two the main roads of the plantation were usually laid out. These in turn became the boundaries of land. One of the first conceptions that highways could be used as a means of recreation was the establishment of bridle paths on the plantations for the use of the owners and their guests. It was only natural that the early surveyors who migrated from this part of the country should embody in their plans the practices of the regions from whence they came. George Washington was one of the many of these who helped to establish the methods of the Virginia road makers in the regions further west.

In New England, the topography plus the highly individualistic characteristics of the New England farmer led to a "help yourself" method of land settlement with roads laid out more on the "go-where-you-please" method, which in many cases prevented the use of the highway as a boundary. However, a time saving desire was evidenced in that to avoid too roundabout a procedure many of the roads cross the hills at the highest point. Directness of route, apart from mere pleasure walks or drives, has been a persistent factor from the begnining in road locations, wherever topography permitted and frequently when it did not. Thus Gibbon, the historian, states that the public roads of ancient Rome were divided by milestones and ran in a direct line from one city to another, with little respect for obstacles either of nature or of private property; mountains being perforated and bold arches thrown over the broadest and most rapid streams. Despite the limitations of cut-up lots and changing traffic needs the continued use of some of these more strategic old paths may indicate that the New England practice has much to recommend it over the rectangular Western system where the straightest routes often involve the longest way round. A wise combination is in order and is being evolved.

Social Objectives Back of Present Plans.—Let us now endeavor to glimpse the philosophy and social objectives back of the present plans of highway development as revealed in the aims and accomplishments of some of the more outstanding regional planning associations. As commonly regarded, and as defined under highway law, an ordinary highway is predominantly a public right-of-way for all classes of traffic with a public right of access to and from the land which abuts it on both sides. A superhighway in turn is a very wide highway.[4] A parkway is a park and road combined, with a special legal quality that denies the right to access to it from abutting land. A parkway, however, should never be a speedway. A boulevard is a highway that is furnished with trees, grass, shrubs or similar landscape features and may thus resemble a parkway, but the right of access from abutting private property is not denied in the case of a boulevard.

In general it will be appreciated that a thoroughly comprehensive regional highway plan involves as well a system of parkways and boulevards co-ordinated with the actual highways on the one hand and with the parks, forest preserves and other recreational areas on the other hand.

The Westchester County Development.—The most well known highway and parkway development to date is that of the Westchester County Park Commission,[5] comprehended in turn within the larger New York Regional Plan. A study of this commission's accomplishments since 1922, involving the development of 160 miles of parkways, the expenditure of over $60,000,000 and the increase of the assessed valuation of taxable properties in the county by 1929 to more than double that of 1922, reveals the following social objectives. First, the creation of scenic beauty together with the provision of open recreational areas along the highways of the county; second, the relief of motor traffic by co-ordinating new parkway developments with older existing highways; third, the improvement and safeguarding of traffic by resurfacing and the elimination of dangerous curves, grades and crossings; fourth, the further enhancement of through traffic as well as the conservation of the smaller communities by the construction of village by-passes; fifth, the provision of natural drainage routes of trunk sewers together with the possible future locations of water supply conduits and other public utility service features; and lastly, but not least, the increase and stabilization of land values.

In these developments the State Department of Public Works of New York State has worked in close cooperation with the County Commission. Thus a pleasing degree of cooperation was effected whereby the Park Commission had charge of the designing and construction of the bridges and intersections of the parkways and the state highways. In the last few years there has been very little construction of county highways since the commission has felt that there was a sufficient development of these to meet the need. Hence the main effort of the County Park Commission has been directed to the development of the parkway system. There is a definite control of concessions in the parkway management and throughout the park development so that for the last two or three years the entire park system has been self supporting in regard to operation and maintenance. In addition to safeguarding the economic functioning of the system, the artistic aspect of the development is maintained by the commission's control of the sign board evil and of the architecture of service stations.

The New York Regional Plan.—The most comprehensive of all regional plans in its inception is the New York Regional Plan,[6] which in turn is counted as outstanding in the field of highway planning. The key to the New York Region's highway system is the Metropolitan Loop or belt line highway which circles the most intensively

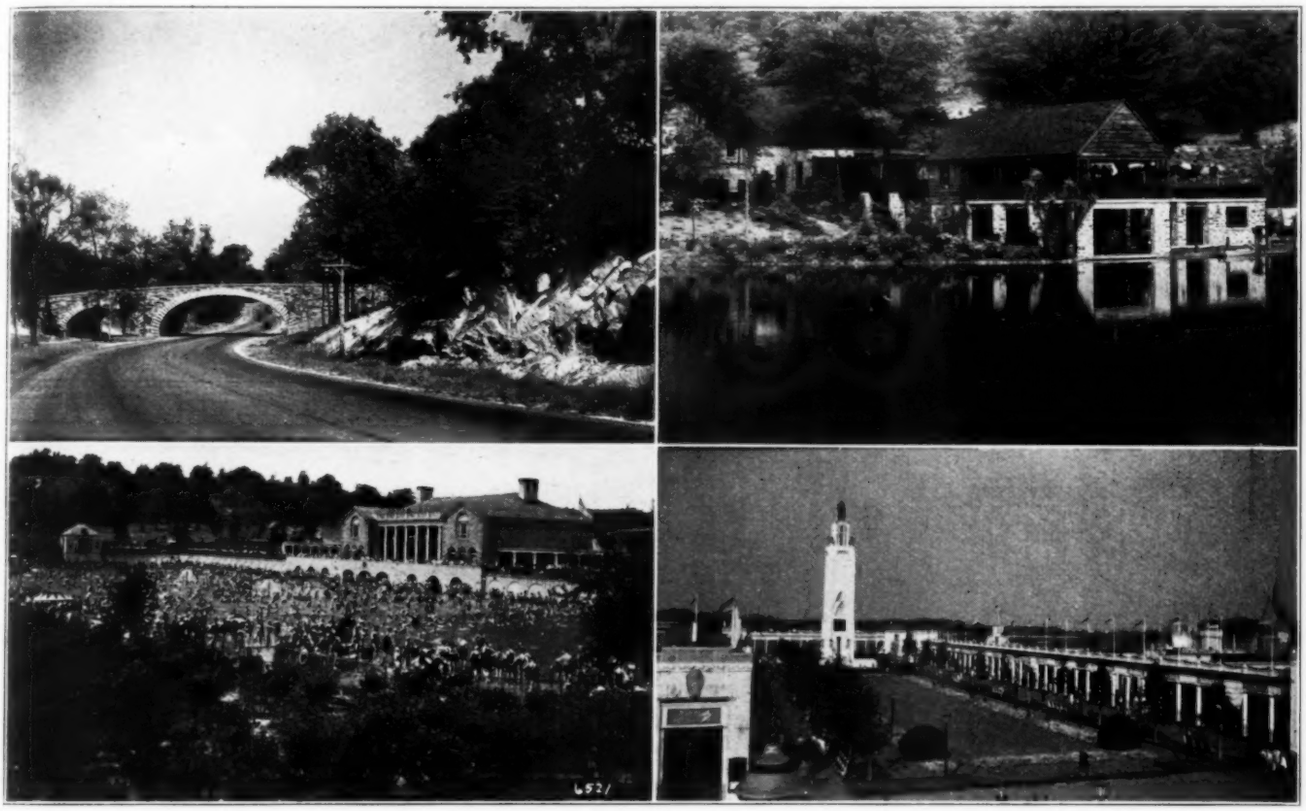
[1] J. Bruhnes, La Geographie Humaine (3rd Ed.), Paris, 1925.
[2] See also James Harlean, Land Planning in the United States for the City, State and Nation. Macmillan, 1926, pp. 20–25; 384–388.
[3] Bristol and Bath Regional Planning Scheme, 1930, p. 22.
[4] According to a Report of the Board of Wayne County (Detroit) Commissioners on Proposed County Superhighways Within the Metropolitan Area, 1929. A "superhighway" refers to a road or street with a 204-ft. width of right-of-way. See page 5.
[5] Regional Plan of New York and Its Environs, Volume I, The Graphic Regional Plan. See especially pages 245ff and 271ff. (Also separate reports.)
[6] Ibid., pp. 210–307.

developed areas, business and residential, in the region, and which, although involving most of the regionally central urban development, in turn corresponds to an enlargement of the focal point of traffic or the main street center of cities themselves and of smaller communities.

The Metropolitan Loop development conserves in the main the rectangular or gridiron plan for the business heart of the region; provides for a system of radial and circumferential connecting highways for the region outside the loop—the radial routes to extend from the outer edges of the region to the highway loop and then to connect with the system of inner routes already existing or designed; and creates a metropolitan by-pass which

Within the loop the street system is quite definitely fixed by the intensive development that has already taken place. With few exceptions the main highways either parallel the general direction of the Hudson River or are at right angles thereto. Provision is made for suitable diagonal connections between the different inner routes and the radial routes at the outer edges of the area circumscribed by the loop. The Metropolitan By-Pass would offer a convenient by-pass around all that area which is or is likely to become intensively developed, and would also avoid the built-up areas in all the larger communities within those outer areas through which it passes.[8]

The New York Regional Highway Plan also provides



Views in Development of Westchester County (New York) Park Commission. Upper Left: Hutchinson River Parkway Mill Road Bridge. Upper Right: Concession Group at Woodlands Lake on Saw Mill Parkway. Lower Left: Swimming Pool at Tibbetts Brook. Lower Right: Play Land, Colonnade and Music Tower.

will take northeast and southwest bound traffic outside of the large central cities of the region.

The principle of the Metropolitan Loop as applied to the New York Region is shown diagramatically in a number of figures in Volume I, The Graphic Regional Plan.[7] The loop itself extends from Elizabeth, N. J., through Summit and Paterson on the west and Englewood on the north, skirting these towns in the main, crosses the Bronx at 170th St. and circles Queens over Cross Island Boulevard near its eastern boundary and south to Conduit Boulevard thence through southern Brooklyn over Fairfield Ave., Flatlands Ave., 86th St. and 7th Ave., thence over Clove Road across the upper end of the Borough of Richmond. Thus it takes in a wide territory, its course on the average lying about 12 miles distant from New York City's Hall. A portion of it is to be an express route while throughout other areas it will have park features. According to the 1931 Report of the New York Regional Plan Association, this proposed Metropolitan Highway Loop which is the nucleus of the plan, is well on the way to realization.

for a system of express highways which as far as possible skirt the edges of the more intensive development and yet cross the Metropolitan Loop at strategic thrusts. Through intensively built-up areas the express highway is to be placed on a viaduct above the existing street system or in a tunnel or open cut below it. In more open country the differentiated express highway will remain on the surface with, however, provisions for the separation of grades at all major highway crossings.[9]

The Graphic Plan further specifically recommends[10] that there be combined with the arterial highways, bridle, cycling and walking paths as well as recreation areas nearby, similar to that manner of the Westchester County parkway system. It also lays down the principle[11] that the highway system be developed on lines that will promote the best economic use of land abutting upon it and there-

[7]Regional Plan of New York and Its Environs, Volume I, The Graphic Regional Plan. See especially Figs. 1 and 2, pp. 178, 179; also Figs. 11 and 12, pp. 218, 219.
[8]Ibid., Fig. 13, p. 222.
[9]Ibid., Fig. 17, p. 266.
[10]Ibid., p. 212.
[11]Ibid.

by create new values in land and buildings following expenditures on highway improvements. The creation of these new values will likewise serve to enable public authorities to recoup themselves indirectly for a part of the cost of improvements through the increase of tax revenues. In line with this principle is the one following it, viz., that the arterial highway system should be co-ordinated with the means of communication by rail. This last principle is one of the keynotes of Mexico's National Plan.

Regional Planning in Los Angeles County, Calif.—The Los Angeles County Regional Planning Commission is next to that of New York in the extent of its studies and publications. The county is divided into seven natuural physical divisions, each the subject of a special study and of reports. The Master Plan[12] involves 3,000 miles of highways 100 ft. or more in width. For a representative consideration we may take the 1931 report of the long Beach-Redondo Area,[13] since the industrial district which lies within this area forms the real heart of metropolitan Los Angeles, and no other section is as diversified in use and in character as this one.

This plan emphasizes an important feature. It provides local service streets for automobile parking which amount to setbacks formed by a parkway strip at each major business highway intersection. These strips extend a block or its portion necessary to envelop the business centers on major highways, and thereby conserve shopping interests without interfering with through traffic. An apt diagram of this development is given on page 136 of the report.

This idea is further developed in the traffic circle[14] suggested especially for the intersection of several highways, and also in the community plaza[15] likewise created by the introduction of large parking areas between the roadway and the business buildings. Such a plan creates a community center of distinction by combining business site advantages with traffic control and beauty of design.

The highway section of the Master Plan has recently been preparing building line ordinances for heavily traveled narrow streets with sharp corners and abrupt turns, regulating the erection of buildings to conform to definite lines in turn suited to modern living conditions. The Board of Supervisors has secured the passage of many such ordinances based solely on the police power for the promotion of public health and safety.[16]

Both the New York and Los Angeles Plans provide for airport locations at otherwise qualified sites with accessibility uppermost in mind. The Los Angeles Plan specifically states that no highway should be so placed as to injure an ideal site for a future airport.

The Chicago Regional Plan.—The Chicago Regional Plan covers a radius larger than either that of the New York or Los Angeles Plans. For many years the city of Chicago's boulevard system, forming the inter-connections between the more important parks, has been an outstanding civic accomplishment. The regional plan in turn envisions a new outer circuit boulevard, which would extend all the way around Chicago and have the same relationship to existing roads to and from Chicago as the already established boulevard system has to the interior thoroughfares.

The Chicago Regional Planning Association has encouraged the improvement of highways within the region and the acquisition of right-of-ways for important state highways within the region, while at the same time concerning itself with parkway developments, forest preserves, and tree planting along highways. During the past two years sixty miles of highway right-of-way have been planted to trees in Cook and three other counties in the region. The removal and control of sign boards has had major attention.

The Chicago Regional Planning Association has long felt that the highway system throughout Illinois has been well completed except in the municipalities. Therefore for the next four or five years it expects to direct its highway efforts principally toward the completion of major thoroughfares in cities in its region, which extends for a 50 mile radius from the loop.[17]

The Philadelphia Tri-State District Plan.—The Philadelphian Tri-State District Plan conceives a comprehensixe philosophy of regional highway development.[18] It is likewise based on the principle of radial trunk highways with connecting circumferential routes. Among its stated principles in laying down the theoretical highway plan is the striking one that main thoroughfares within and primary highway connections between the principal cities of the region be designed in such a manner as to encourage centralized development as opposed to string expansion along the primary highways.[19] In line with this, all primary highways are to by-pass traffic centers whenever possible, and main thoroughfares in the future are to be regarded as less desirable frontage for either business, residence or industry. However, along with this diminishing importance of highway frontage the principle of local service ways as developed especially in connection with the Los Angeles Plan is recognized. The Philadelphia Plan holds that the only way in which frontage upon primary highways can be contemplated is by provision of parallel local service roadways or by the use of park strips to intervene between the central roadway and the developed frontage on either side.

The Lucas County, Ohio (Toledo), Planning Commission stresses an important economic aspect in the development of regional highways. It holds[20] that since the need of wider roads is so generally appreciated and since the opportunities for the diversion and separation of traffic increase as the city limits are approached, that practically all the required additional right-of-way land can be secured by voluntary dedication in the light of a well-considered major highway plan. This voluntary action would be in the main forthcoming since owners would find it easier to dedicate property than to pay the increased taxes and assessments resulting from a purchasing policy. However, the plan also suggests a deferred dedication policy where necessary, whereby this could be effected with an agreement to establish a building line and to dedicate the necessary land for the wider highway when the property is either sold or subdivided.

Other American plans might be considered, but these are certainly representative and in the main embody the essential community features in the development of regional highways.

Objective of English Planning Scheme.—The viewpoint of the English planning scheme[21] in regard to the development of regional highways embodies in the main the essential features as already discussed in the domi-

[12]The Master Plan, The Regional Planning Commission, County of Los Angeles, January, 1929, pp. 14–17.
[13]County of Los Angeles, Regional Plan of Highways, Section 4, Long Beach–Redondo Area, 1931.
[14]Ibid. See diagram, p. 48.
[15]Ibid. See diagram, p. 49.
[16]Op. cit.
[17]From a letter to the author from Robert Kingery, secretary of the Chicago Regional Planning Association, as of date Dec. 14, 1932.
[18]A Statement of the Effects of Population Trends Upon Planning in the Philadelphia Tri-State District, by the Population Committee of the Regional Planning Federation, December, 1930.
[19]"Theory of Planning the Region as Exemplified by the Philadelphia Tri-State Plan," Russell Van Nest Black, City Planning, July, 1930, pp. 184–198.
[20]A System of Major Highways and Parkways for Lucas County, Ohio. Lucas County Planning Commission, 1928.

nant American plans. There are, however, a few objectives that are not mentioned in these latter. In England, many of the road or highway plans are considered in the light of their military value, and in the treatment of open spaces there is considerable attention given the military value of certain regions as areas for annual maneuvers and for camps and training grounds in wartime. The function of the regional planner to provide for the preservation of ancient sites and buildings and to make them accessible to the public is recognized. These together with important monuments should become focal points of historic, recreational and scenic interest around which roadways and parks should be developed more adequately. Likewise the need of protecting small groups of trees and even single specimens, which add so much to the charm of wayside development, is recognized. The English are strong advocates of a system of lanes which from time immemorial have been an outstanding feature of English countrysides. Moreover, it is the English theory that the highways in the country and at the approaches of the towns should not be given over to petty commercial interests and cheap residences. The English plans also emphasize bye-passes around villages, and ring roads and radial arterial highways as the structural bases of their regional plans.

Conclusions: Major Principles.—In conclusion, the following major principles of regional highway development may be designated as revealed in the outstanding regional plans.

The Principle of:

1. The Metropolitan Loop, with radial and circumferential thoroughfares—the ring roads of the English plans.
2. The lessening value of highway frontage as revealed in the:
   a. Creation of village and metropolitan by-passes;
   b. Construction of local service ways off primary highways at each major business intersection;
   c. Control over the erection of buildings at strategic corners;
   d. Encouragement of centralized community development as opposed to a string expansion along primary highways, a development further reflected in the creation of traffic circles and community plazas;
   e. Construction of bridle, cycling and walking paths along highways;
   f. Value attached to scenic beauty;
   g. Use of highways as natural drainage routes of trunk line sewers, water mains, and other major utility service features.
3. Highway differentiation, as revealed in the construction of different types and width of highways, of speed and express ways, and of recreational facilities in conjunction with highways themselves.
4. The coordination of the arterial highway system with the means of communication by rail and by air—and in England with due emphasis on the military value of highways.
5. The relief and control of motor traffic as revealed in the aforementioned developments.
6. The improvement and safeguarding of motor traffic by resurfacing and the elimination of dangerous curves, grades and crossings—especially superhighway crossings.
7. The highway as a recreational agency and as a link in the fuller development of parks, forest preserves, reservations, and in England especially of historic sites and monuments; this principle further evidenced in the control of concessions along highways, and in parks coordinated with them.
8. The highway as an embodiment and preserver of scenic beauty, as revealed in the:
   a. Elimination and control of the sign board;
   b. Control of the architecture of service stations;
   c. Planting and preservation of trees along the right-of-way;
   d. Highway location and construction so as to preserve the natural beauty, vistas, and views of the open country.
9. The highway serving its basic economic purpose in the increase and stabilization of land values.

[21] West Surrey Regional Planning Scheme, 1931, pp. 15–28. Bristol and Bath Regional Planning Scheme, 19030, pp. 21–26. West Middlesex Regional Planning Scheme, 1924, pp. 30–41. The Doncaster Regional Planning Scheme, 1922, pp. 34–48. Manchester and District oJint Town Planning Advisory Committee, pp. 37–49.

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Advance Planning of Public Works in Pennsylvania

The following is a digest of H. R. 1566 providing for six-year advance planning of public works by the state, the cities and principal counties, which has been passed by the Pennsylvania legislature.

Creates a permanent State Public Works Planning Board to formulate annually a six-year comprehensive plan and financial program of state public works; to promote greater economy in construction; to aid in stabilizing industry and employment through the proper regulation of public construction and the conservation and control of part of the public credit for use in periods of depression.

Requires each state department having charge of construction of public works to plan and program its proposed projects six years in advance and to prepare detailed plans and specifications for work at least one year ahead.

Requires that an advisory opinion of the State Board upon public works plans and programs prepared by any state agency, shall accompany requests to the legislture for appropriations for proposed capital public works.

Authorizes cities and principal counties to create local public works planning boards with functions similar to those of the State Board.

Provides that if cities and principal counties do not set up such boards within 2½ years the advisory opinion of the State Board must be sought upon their proposed capital public works before voters are asked to authorize the borrowing of money for the same. This advisory opinion can be rejected by the voters after a public hearing in the locality affected. Cities are given an incentive to set up such boards by the provision that when they do so, mandatory requirements for an advisory opinion of the State Board will be withdrawn.

No new authority, state or local, is created which can override or displace the functions of present responsible local governments.

Authorizes State Public Works Planning Board to serve as a clearing house for approved local planning boards for information and data relating to public works plans and programs.

Provides for planning by the State Board for immediate public works requirements in the present emergency.

Is a permanent measure for more complete integration of the function of planning for the state's physical development with the function of planning future financial policies.

The bill is based on the Federal legislation creating the Federal Employment Stabilization Board now in operation and on state laws for control of local finances in North Carolina and Indiana now in operation.

Taxes in Wisconsin and Expenditures for Highway Purposes

THE U. S. Bureau of Public Roads in cooperation with the University of Wisconsin has been conducting recently a series of studies in a number of states involving the expenditures for highway purposes and the incidence of taxes for these and other purposes. During the late months of 1930 and all of 1931 such an investigation was made in Wisconsin. A summary of the voluminous report resulting from the studies, prepared by the Division of Highway Transport of the Bureau, occupies the entire April issue of Public Roads. An abstract of this matter follows: This digest covering the studies in Wisconsin was prepared in order that the results might be made available insofar as they apply to the general problem of highway taxes, the distribution of expenditures, and the relation of both to the use of highways. Other tax relationships are incidentally revealed.

The calendar year 1930 was chosen for study because it was a census year and the latest year for which data were available. To classify the incidence of taxation, the state was divided into groups of governmental units and into classes of residence. To distribute expenditure, the highway classifications in use in the state were adopted.

With respect to classes of residence, the state was divided into towns (comprising all rural areas) and incorporated places, the latter being classified as follows:

Places having a population up to 2,500.
Places having a population of 2,500 to 15,000.
Places having a population of 15,000 to 75,000.
Places having a population of 75,000 to 300,000.*
Places having a population of 300,000 upward.†

Certain of the smaller incorporated places are known as villages, but all are included in the classification given above. In the portion of the report dealing with motor vehicles and motor-vehicle travel the village classification was used.

Rules Governing Study.—The entire study was governed by the following rules:

1. To consider as taxes of each class of units of government only those taxes levied by act of its proper officials.

2. To consider as receipts only those funds finally credited as having been expended (not transferred) by officials of that unit of government.

3. To consider as expenditures only those funds disbursed (not transferred) under the direction of the officials of that unit of government in or for that unit of government.

Four governmental purposes only were recognized in the study, and all items were allocated under one or the other of these. These purposes were as follows:

1. *Highways.*—All items having to do with the construction, maintenance, marking and signing, and administration of all public highways.

2. *Education.*—All items having to do with the construction, maintenance, teaching, and administration of all public schools, and also of libraries.

3. *Public protection and benefit.*—All items having to do with the protection of lives and property and the pleasure of the people, including police and fire protection, courts and their officials, parks and playgrounds, and charitable and penal activities.

4. *Government.*—All items having to do with the general administration of those public affairs of a unit of government which are not capable of allocation to one of the three public purposes mentioned above.

Population and Assessed Valuation.—In 1930 Wisconsin had 71 counties, subdivided into 1,280 towns (rural units of government), 359 incorporated villages, and 144 incorporated cities. Milwaukee city and County was the only metropolitan area, although there were 18 other cities having a population of over 15,000. Of the population of 2,939,006 in 1930, 37.1 percent lived in the towns (rural areas); 10 percent in incorporated places having a population of 2,500 or less; 12.4 percent in places having a population of 2,500 to 15,000; 20.8 percent in places having a population of 15,000 to 75,000, and 19.7 percent in Milwaukee city, which had a population of 578,249. In short, 37.1 percent of the population was rural and 62.9 percent was urban.

The assessed valuation of all taxable property in Wisconsin in 1930 was approximately $5,896,513,000. Thirty-seven percent of the assessed valuation was in the towns; 7.3 percent in incorporated places having a population of 2,500 or less; 10.1 percent in places having a population of 2,500 to 15,000; 21.9 percent in places having a population of 15,000 to 75,000; and 23.7 percent was in Milwaukee city. Thus, 37 percent of the valuation was in the rural areas, and 63 percent in the urban areas. Of the total valuation, 61.1 percent was in the 13 highest valued counties, which comprise only 13.2 percent of the total area of the State.

Highway Systems in 1930.—In 1930 there were three highway systems in the State: (1) The State trunk highway system consisting of 10,218 miles, which was again divided into 2,345 miles of primary Federal-aid highways, 3,246 miles of secondary Federal-aid highways, and 4,627 miles of other State trunk highways; (2) the county trunk highway system consisting of 13,827 miles; and (3) the remaining roads and streets, for the most part strictly local roads, amountnig to 65,494 miles. Of this mileage, 58,934 miles were local town roads, 1,567 miles were village streets, and 4,993 miles were city streets. A summary and percentage relationship is given in Table 1.

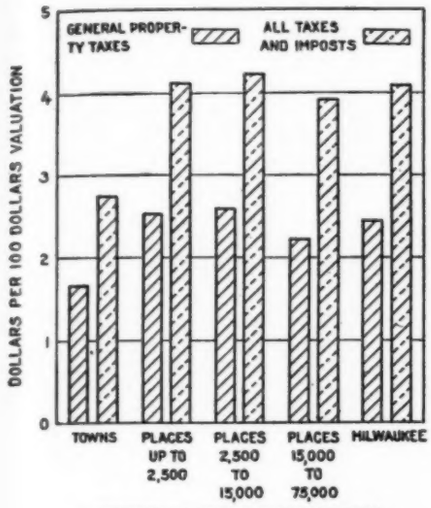
TABLE 1.—*Classification of highways, roads, and streets in* 1930

Type	Miles	Percentage of total
State highway system	10,218	11.4
County trunk highway system	13,827	15.4
Town roads	58,934	65.8
Village streets	1,567	1.8
City streets	4,993	5.6
Total	89,539	100.0

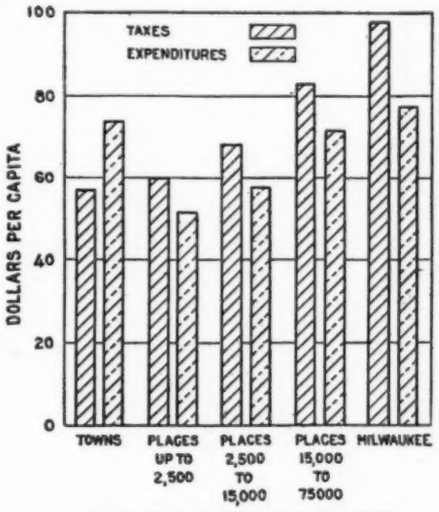
There were 39,643 miles of surfaced rural highways in Wisconsin on December 30, 1930. This was 47.8 percent of all rural highways. Of this mileage, 3,576 miles (9 percent) were concrete or its equivalent; 781 miles (2 percent) were bituminous macadam; 35,286 miles (89 percent) were crushed stone, gravel, and other minor surfacings. Following are the mileages surfaced

*No incorporated places of this classification appear in Wisconsin.
†The city of Milwaukee is alone in this class in Wisconsin.

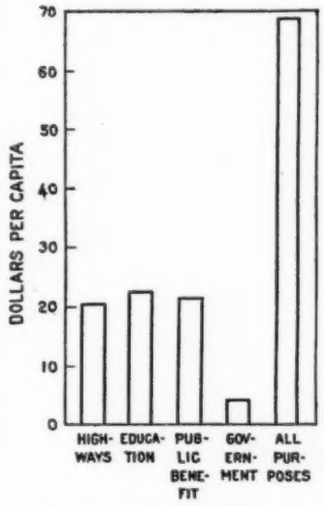
THOUSANDS OF MILES
CENTS PER VEHICLE-MILE



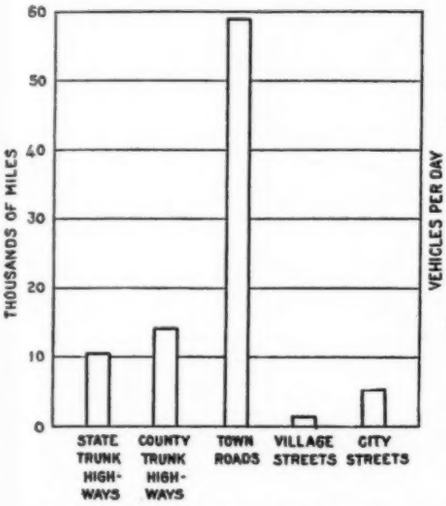
AVERAGE TAX RATES IN THE SEVERAL CLASSES OF GOVERNMENTAL UNIT



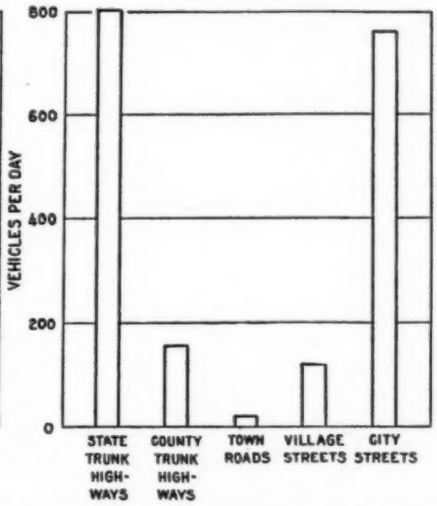
PER CAPITA TAXES AND PER CAPITA EXPENDITURES IN THE SEVERAL CLASSES OF GOVERNMENTAL UNIT



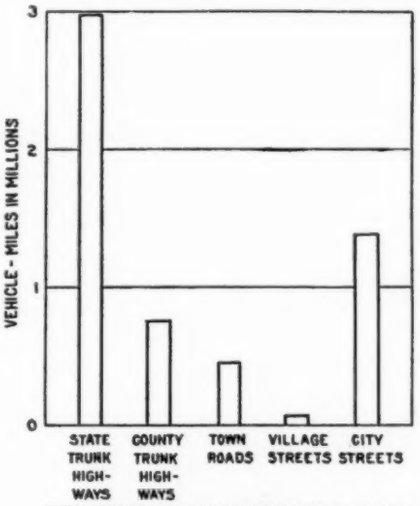
PER CAPITA EXPENDITURES CLASSIFIED BY PURPOSE



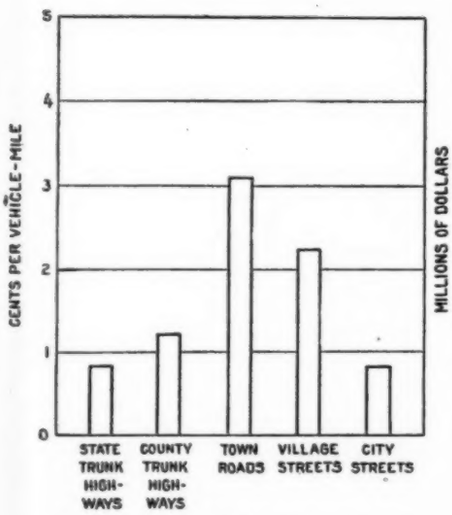
MILEAGE OF HIGHWAY SYSTEMS AND URBAN STREETS



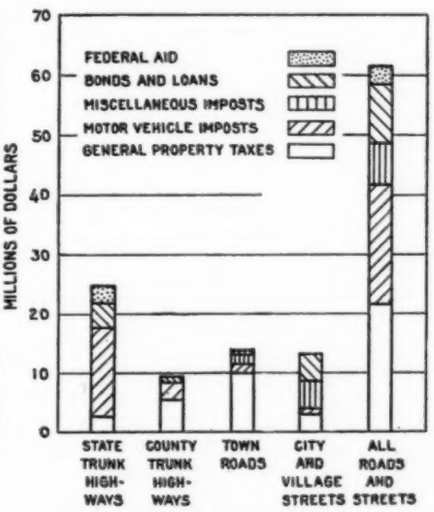
AVERAGE DENSITY OF TRAFFIC ON HIGHWAY SYSTEMS AND URBAN STREETS



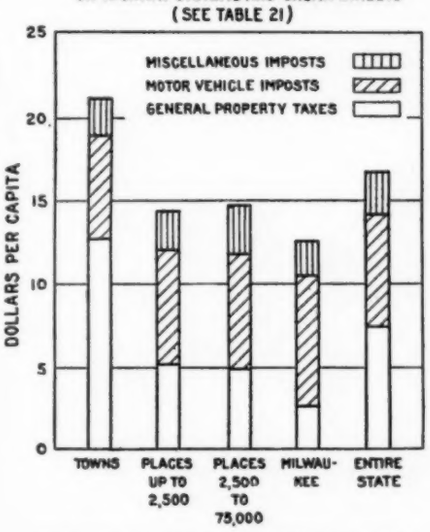
TOTAL TRAFFIC OF WISCONSIN VEHICLES IN 1930 ON HIGHWAY SYSTEMS AND URBAN STREETS (SEE TABLE 21)



EXPENDITURES PER VEHICLE-MILE ON HIGHWAY SYSTEMS AND URBAN STREETS



TOTAL EXPENDITURES ON HIGHWAY SYSTEMS AND URBAN STREETS, SHOWING SOURCES OF FUNDS



PER CAPITA CONTRIBUTIONS BY RESIDENTS OF THE SEVERAL CLASSES OF GOVERNMENTAL UNIT TO TAXES AND IMPOSTS EXPENDED ON ROADS AND STREETS

and percentage of all mileage surfaced on the several rural highway systems:

	Miles surfaced	Percentage surfaced
Federal-aid highways (primary).....	2,341	99.8
Federal-aid highways (secondary).....	3,090	95.2
Other State trunk highways.....	3,932	85.0
Whole State trunk highway system.....	9,363	91.6
County trunk highways.....	9,283	67.1
Local town roads	20,997	35.6

Out of the 4,357 miles of high-type surfaces, 3,714 miles (85.2 percent) were on the State trunk highway system; 630 miles (14.5 percent) were on the county trunk highway system; and 13 miles (0.3 percent) were on local roads.

One county (Milwaukee) had every mile of road in the county surfaced, with 30 percent surfaced with concrete or its equivalent. The least populous group of counties had only 26 percent of its mileage surfaced. The most populous group after Milwaukee County had 80 percent of its mileage surfaced, of which about one sixth was of high type.

Personal Reports Used to Obtain Data on Mileage Traveled and Incidence of Motor-Vehicle Taxation.—As it was the general purpose of the study to determine the amount of the various taxes and imposts, who paid them, where the money was expended and for what purpose, and to disclose the relationships between the various taxes and expenditures, it was necessary to ascertain the distribution of automotive revenues and gasoline taxes paid. For this purpose, personal reports were gathered from 5,116 vehicle owners to determine the mileage traveled on the different classifications of highways. A distribution of revenue was then made on this basis. Only those owners were questioned whose motor vehicles operated through the whole of 1930.

Receipts from Taxation.—The total receipts from all taxes and imposts in 1930 were $211,679,900, of which $126,998,400 were derived from the general property tax, $12,976,300 from motor vehicle and drivers' license fees, $7,947,200 from the gasoline tax, and $63,758,000 from other miscellaneous sources.

Conclusions:—The conclusions as given in Public Roads follow:

1. Rural property pays no tax for urban streets.
2. Sixty-one percent of the road tax on urban property goes for rural roads; 39 percent for city streets.
3. Of the total road tax on rural property:
   (*a*) 11.7 percent goes to state trunk highways;
   (*b*) 22.6 percent goes to county trunk highways;
   (*c*) 65.7 percent goes to local rural (town) roads.
4. Of the total road tax on city property:
   (*a*) 16.7 percent goes to state trunk highways.
   (*b*) 32.1 percent goes to county trunk highways;
   (*c*) 11.8 percent goes to local rural (town) roads;
   (*d*) 39.4 percent goes to city and village streets.
5. Since, of the total property valuation of $5,896,513,000, 37 percent, or $2,181,710,000, was rural, and 63 percent, or $3,714,803,000, was urban:
   (*a*) Expenditures from property taxes for all highways were at the following rates:
   Rural—63.3 cts. per $100;
   Urban—21.2 cts. per $100.
   (*b*) Expenditures from property taxes for state trunk highways were at the following rates:
   Rural—7.4 cts. per $100;
   Urban—3.5 cts. per $100.
   (*c*) Expenditures from property taxes for county trunk highways were at the following rates:
   Rural—14.3 cts. per $100;
   Urban—6.8 cts. per $100.
   (*d*) Expenditures from property taxes for local rural (town) roads were at the following rates:
   Rural—41.6 cts. per $100;
   Urban—2.5 cts. per $100.
   (*e*) Expenditures from property taxes for city and village streets were at the following rates:
   Rural—no tax;
   Urban—8.4 cts. per $100.
6. Of the total property taxes expended on all roads:
   (*a*) 13.5 percent was expended on state trunk highways, upon which 52.7 percent of the total travel occurs;
   (*b*) 26.0 percent was expended on county trunk highways, upon which 13.6 percent of the total travel occurs;
   (*c*) 46.1 percent was expended on local rural (town) roads, upon which 7.9 percent of the total travel occurs;
   (*d*) 14.4 percent was expended on city and village streets, upon which 25.8 percent of the total travel occurs.
7. Of the total motor-vehicle imposts expended on all classes of roads and streets:
   (*a*) Rural motor-vehicle owners (residents of towns) paid 33.9 percent, and travel by these same rural owners made up 31.9 percent of the total travel on all classes of roads and streets;
   (*b*) City and village motor-vehicle owners paid 66.1 percent and made up 68.1 percent of the total travel.
8. Of the total motor vehicle imposts:
   (*a*) 73.8 percent was expended on state trunk highways, upon which 52.7 percent of the total travel occurs;
   (*b*) 15.5 percent was expended on county trunk highways, upon which 13.6 percent of the total travel occurs;
   (*c*) 7.3 percent was expended on local rural (town) roads, upon which 7.9 percent of the total travel occurs;
   (*d*) 3.4 percent was expended on city and village streets, upon which 25.8 percent of the total travel occurs.
9. Of all imposts and taxes expended on all roads:
   (*a*) 36.4 percent was expended on state trunk highways, upon which 52.7 percent of the total travel occurs;
   (*b*) 17.9 percent was expended on county trunk highways, upon which 13.6 percent of the total travel occurs.
   (*c*) 28.2 percent was expanded on local rural (town)

TABLE II.—COMPARISON OF TAXATION AND EXPENDITURES IN WISCONSIN IN 1930

$1,000 in taxes: Residents of	Pay—	In—	$1,000 in expenditures: Division by purpose.	Subdivision by highway system.	Source of expenditure.	Amt.	Pct.	*—
Towns	$180.22	Property tax, $599.95.	Education, $325.77.	State highways, $123.24.	Taxes paid in:			
Places up to 2,500	51.00				Towns	$32.78	26.60	35.7
Places 2,500 to 15,000	71.45				Villages and cities	54.89	44.53	64.3
Places 15,000 to 75,000	136.91				Federal aid	15.08	12.24	....
Milwaukee	160.37				Proceeds of bonds and loans	20.49	16.63	....
Towns	33.50	Motor-vehicle fees and gasoline tax, $98.84.	Highways, $302.80.	County trunk highways, $46.63.	Taxes paid in:			
Places up to 2,500	10.15				Towns	20.56	44.08	51.6
Places 2,500 to 15,000	11.27				Villages and cities	22.62	48.51	48.4
Places 15,000 to 75,000	22.09				Proceeds of bonds and loans	3.45	7.41	....
Milwaukee	21.83		Public benefit, $309.61.	Town roads, $68.74.	Taxes paid in:			
Towns	79.82	Other miscellaneous taxes, $301.21.			Towns	58.69	85.37	63.5
Places up to 2,500	22.89				Villages and cities	9.36	13.62	36.5
Places 2,500 to 15,000	34.94				Proceeds of bonds and loans	.69	1.01	....
Places 15,000 to 75,000	79.52		Government, $61.82.	Village and city streets, $64.19.	Taxes paid in:			
Milwaukee	84.04				Towns	1.12	1.75	3.8
					Villages and cities	40.95	63.80	96.2
					Proceeds of bonds and loans	22.12	34.45	....

*Percentage contribution to traffic on system.

roads, upon which 7.9 percent of the total travel occurs;

(*d*) 17.5 percent was expended on city and village streets, upon which 25.8 percent of the total travel occurs.

10. Of the total of all taxes expended on all classes of roads and streets:

(*a*) Rural property and motor-vehicle owners paid 46.9 percent and travel by rural vehicles made up 31.9 percent of the total travel on all classes of roads and streets;

(*b*) City and village property and motor-vehicle owners paid 53.1 percent and city and village vehicles made up 68.1 percent of the total travel.

Taxes and Expenditures Compared.—Table II shows a comparison between the sources of $1,000 in taxes in 1930 and the manner in which $1,000 was expended in the same year.

If it were desired to make the tabulation analogous to a true balance sheet of receipts and outlays for the year, it would be necessary to include proceeds from bonds and loans on the left of the double line, and principal payments on the right; and also to make allowance for balances carried over and carried forward. The complete figures necessary for such a presentation were not available; so that expenditures as given cannot be said to balance receipts from taxes. It is believed, however, that Table II gives a true picture of the relation between tax money received and actual expenditures in the year 1930.

▼

Making Night Driving Safe

By Joe L. Long

SOME two or three generations since, goes the story, a stage coach was making its way across a stretch of the then virgin West and came to a wide, muddy stream in the middle of which stood a post with a signboard showing about a foot above the stream's surface.

On the board appeared this message, "Beware! When this sign is under water, it's too deep to cross."

The party became quite hilarious over the sign—all except a visiting Englishman who remained sober and obviously perplexed. He reread the sign carefully, "Beware! When this sign is under water it's too deep to cross." He found no mis-spelled words, no grammatical errors, and was wholly at a loss as to the cause of the hilarity.

The next afternoon as the party was proceeding on their way, the Englishman suddenly began to laugh heartily. In answer to the query of his perplexed companions he explained, "My word! I just got it, don't you know? The joke about the bally sign. Ha! Ha! What if a fellow couldn't read?"

Well, what if a fellow *can* read? Why, merely because of that ability, should he be asked to read superfluous words about the obvious?

When driving rapidly along a road, especially at night, only a fraction of a second is given to absorb the message of a marker.

If the curved arrow indicating a turn or curve, or the "S" which tells of a reverse curve, is alone on the marker, it is photographed by the eye in a flash comparable to that required by a camera, but if it has words "Left Curve" or "Right Turn" and you are driving at the usual speed of someone going somewhere, the chances are that quite often you will only catch the "Turn" or "Curve" and be uncertain as to whether it was "Right" or "Left."

In every case it will hold your eye away from your road much longer than the one with only the emblem, thus either lessening your speed appreciably or adding to the hazard of driving.

There would seem to be no good reason for any words to explain the universally used emblems for curves and turns, and little more occasion to use letters for side-roads, cross-roads, winding road, or other common warnings, except "Stop" and possibly "Danger" and "Slow" indicators.

Words will doubtless prove safer than any symbol for these, particularly where they are temporary.

The universal preference shown for bright red signs by "Hot Dog" stands, and other road-side caterers has made that color no longer sufficient to arrest attention and a luminous word is about the only safe and effective way to be sure those message register.

It would seem that such a system of marking would need but one more added feature to make it meet with universal approval.

If every indicator, emblem and word could be made as fully visible by night as by day, all of us would be delighted. If we could start out at dusk for a 400-mile trip knowing that we could depend upon every curve and turn arrow, every railroad, cross road, and side road indicator, every route number and every "slow," "danger," and "stop" sign lighting up with a molten metal glow as we come within its range, we could make as good or better time at night as in the day and drive without nervous strain or tired and aching eyes.

It would seem that such a system would indeed approach the ideal, offer us comfort and enjoyment at night travel, and save thousands of lives each year.

Prophecy is a very dangerous indulgence when one uses printer's ink in its practice and tends to become specific as to things to be done and dates of their accomplishment. Fully aware of the risks, the writer predicts that five years from now, not a trunk line highway will be found in the United States with a single traffic marker that is not visible by night as well as day.

Suggestions as to use of standard color signals might be apropos at this time. If the railroad color scheme of green for "'all clear" and "yellow" for "Slow" or "Caution," with red for "Danger" and "Stop" could be used in reflector signs that would be luminous at night and brightly visible by day, we would then have a system as nearly foolproof as possible.

Such a system is now being seriously considered by more than one state.

Recent developments make its cost no longer a matter of uncertainty nor prohibitively high. On paved roads the cost of the change will be less than 1 per cent of the investment and the public needs only to experience the satisfaction and pleasure—as well as assured safety—of such a marking system to insist on its adoption.

▼

Revised Simplified Practice Recommendation on Paving Brick

The printed copies of the revised simplified practice recommendation R1-32 covering vitrified paving brick (eighth edition) are now available, and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 ct. each, according to the division of simplified practice of the Bureau of Standards.

The 1932 revision, described in the current publication, has been recently reaffirmed for another year by the industry's standing committee.

A Practical Method for Taking and Preserving Soil Cores

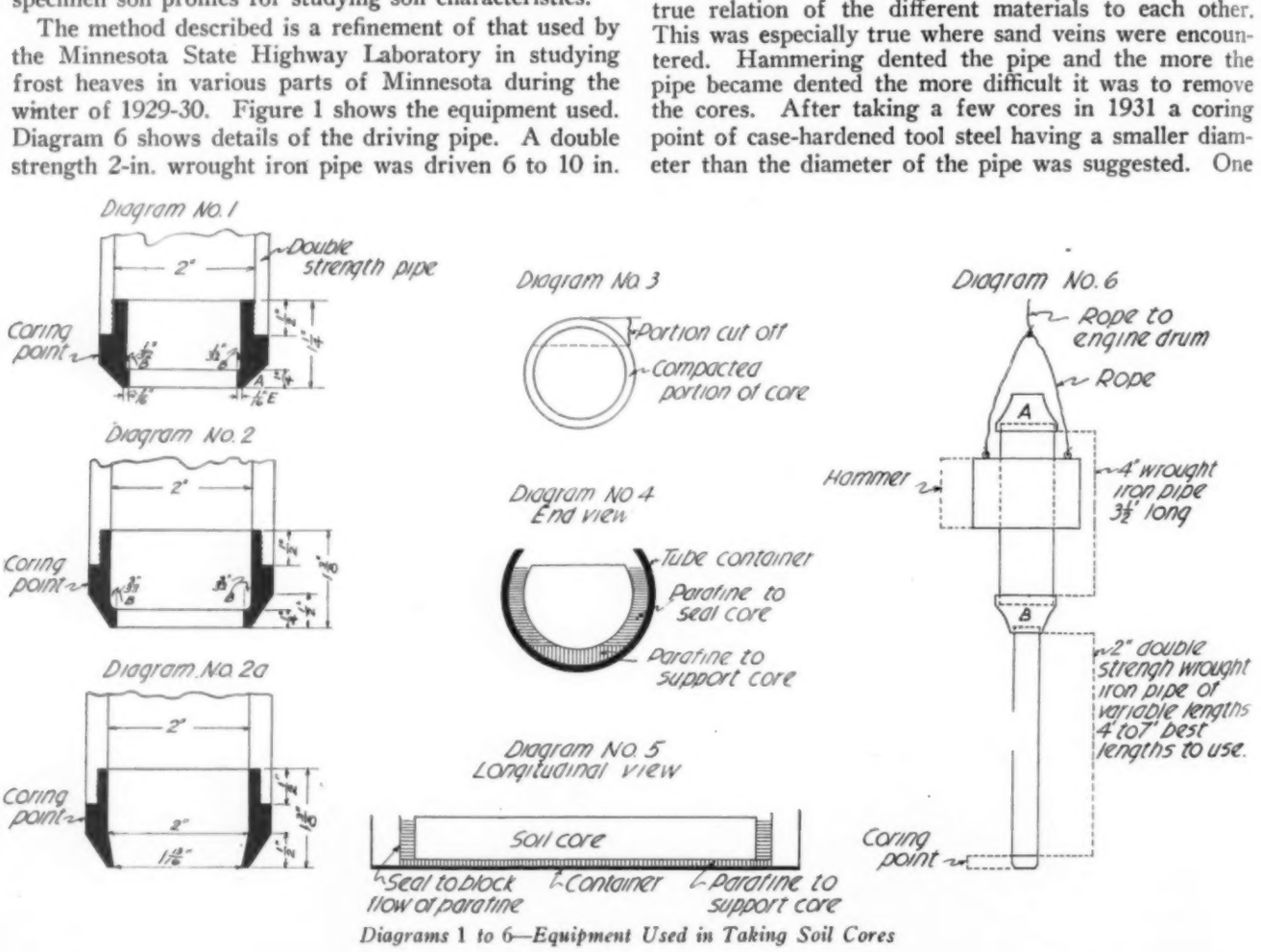
By W. I. WATKINS
Assistant in Soil Survey, U. S. Bureau of Chemistry and Soils

Fig. 1

THE method described in this paper was developed for the purpose of taking and preserving soil cores, to show the character and relation of ice accumulation to the soil characteristics with the idea of adapting this information to road construction. (Figs. 1, 2 and 7.) Although developed for the purpose of studying ice segregation, the method will be readily recognized as valuable in studying the efficiency of construction practices.

The degree of compaction obtained by different weights and types of rollers used on the various materials and heights of lifts composing a road fill may be obtained from samples taken by this method. (See Fig. 2, Core 2.) Similarly the effect and desirability of jetting the different materials used in the construction of fills may be obtained. The method may also be used in securing specimen soil profiles for studying soil characteristics.

The method described is a refinement of that used by the Minnesota State Highway Laboratory in studying frost heaves in various parts of Minnesota during the winter of 1929-30. Figure 1 shows the equipment used. Diagram 6 shows details of the driving pipe. A double strength 2-in. wrought iron pipe was driven 6 to 10 in. into the ground by tightening the rope on drum B (Fig. 1) and then, loosening, allowing the hammer to drop on coupling B (Diagram 6). The pipe was then withdrawn by reversing the rope winding on drum B and striking an upward blow on coupling A (Diagram 6) and the soil core was removed by hammering the pipe. This was slow, cumbersome, and unsatisfactory as the soil cores showed excessive compaction and often came out in chunks so that it was difficult to obtain an idea of the true relation of the different materials to each other. This was especially true where sand veins were encountered. Hammering dented the pipe and the more the pipe became dented the more difficult it was to remove the cores. After taking a few cores in 1931 a coring point of case-hardened tool steel having a smaller diameter than the diameter of the pipe was suggested. One



Diagrams 1 to 6—Equipment Used in Taking Soil Cores

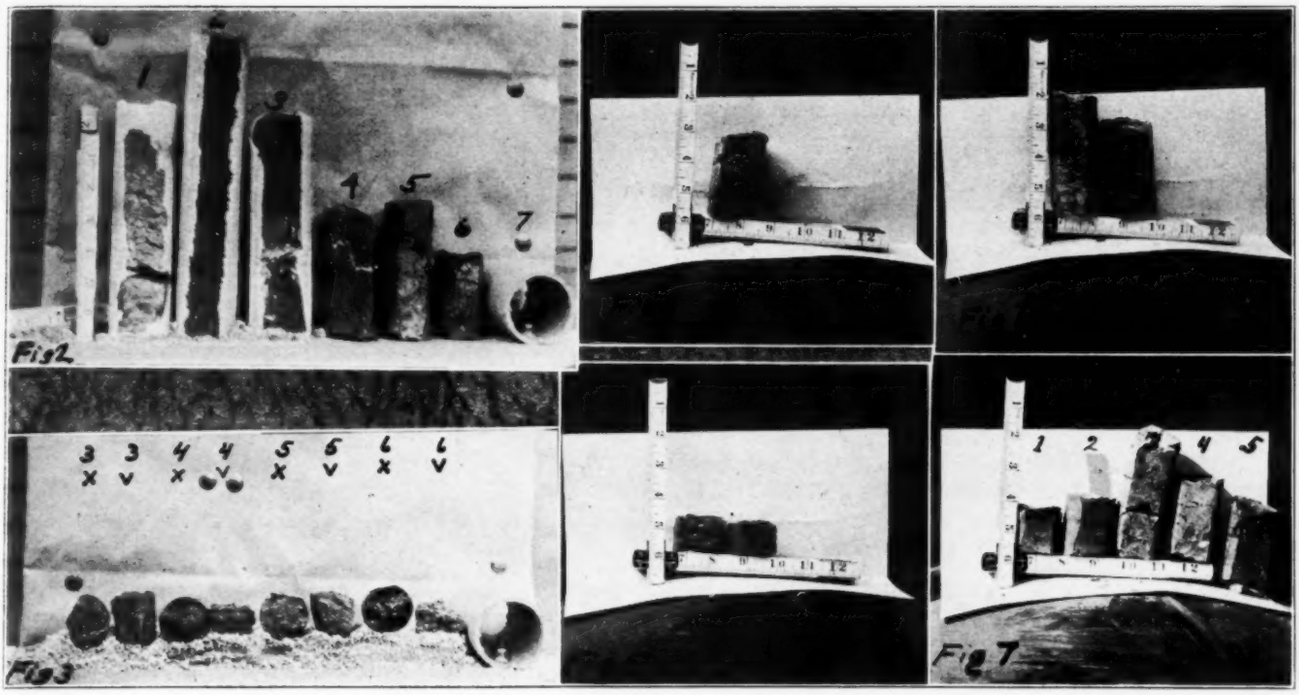


Fig. 2—(1.) Calcareous Silty Clay Loam Till. The Large Void Is An Accumulation of Voids That Originally Existed at Cleavage Planes Below. (2.) Webster Silty Clay Loam. Used as Frost Boil Backfill. The Cracks Are Exaggerated Due to Shrinkage. No Ice Segregation Appeared Below 1 In. Mark on Ruler. Horizontal Cracks Evidently Follow Cleavage Planes Which Were Probably Caused by Rolling. Crack in Middle of Core Occurs in ½ In. Layer of Heavier Soil. (3.) Upper Portion Shows Slight Mosaic Ice Formation. Center Contains Drab "C" Clay Material. Lower Portion Contains Sod. (4.) Clarion Loam or Clay Loam Used as Frost Boil Backfill. All Cracks, Except One Outlined in White, Are Due to Shrinkage. None Penetrate More Than ¼ In. Into Core. See Description of Clarion. (5.) Clarion Loam Used As Frost Boil Backfill. Contains Some Clay Loam Till Soil Material. (6.) Clarion Clay Loam Used As Frost Boil Backfill. Contains Small Amount of Highly Calcareous Transitional Silt Layer. (7.) Cross-Section of Tubes Used in Preserving Cores 1-2-3.*

Fig. 3—Shows Effect of Well Developed Structure. V represents Vertical Break of Core Having Same Number in Fig. 2. X represents Cross-Section Break of Core Having Same Number in Photograph 16-4. Cores Taken with 250 Lb. Hammer. Study Photographs with Magnifying Glass.

Fig. 4—Core Shows Disrupted Condition Due to Using Light Hammer in Taking Core. 160-Lb.

Fig. 5—Ice Layers in Silt Loam. Fig. 6—Ice Layers in Highly Calcareous Silt Clay Loam. The Ice Layers in Figs. 5 and 6 Are Exaggerated and Show Distortion. This Effect Was Caused by Using a Light Hammer in Taking the Cores. 160 Lbs.

Fig. 7—(1.) Silt Loam. (2.) Slightly Heavier Silt Loam. (3.) Upper ⅔ Heavy Silt Loam. Lower ⅓ Clay Loam Till. (4.) Silty Clay Loaw Till. (5.) Heavy Clay Loam.

*Soil Survey of Jackson County, Minnesota, by M. W. Beck in charge, J. Ambrose Elwell, U. S. Department of Agriculture, J. S. Hall, and G. B. Bodman of University of Minnesota Agriculture Experiment Station.

was welded to the pipe and several detachable points were tried.* Diagram 1 shows the point that gave the best results.† Diagram Nos. 2 and 2A show points that might be expected to give better results. This point has the advantage of eliminating the shoulder (Diagram 1), which allows the soil too much play and may cause the soil core to break. A point like that designed by Veihmeyer may also serve the purpose. However, we found the pipe more easily withdrawn when the outside diameter of the coring point was flush with the outside diameter of the pipe. It was difficult to obtain long cores in sands or soils containing sand strata, particularly if the sands did not contain sufficient silts and clays to hold enough moisture to freeze.

The following are important factors in securing the best results. The engine should have sufficient power to prevent stalling under heavy loads. The heavier the hammer the better. Figs. 2 and 4 show difference in cores taken with light (160 lb.) and heavy (250 lb.) hammers. The pipe should be straight, smooth inside and out, and heavy enough to prevent springing when driving. The pipe used was of extra heavy double strength wrought iron 0.218 in. thick. Cutting edge E should be about 1/16 in. Coring collar A should be as short as possible to reduce friction to a minimum. The shoulder at B should be about 3/32 in. so as to allow the free movement of the core into the pipe.

With this equipment, unbroken cores 2 to 3 ft. in length were common. The cores were usually taken to depths of 6 or 7 ft. and by two separate drivings. Occasionally a portion of a core would slip out of the bottom of the pipe. This can be prevented by placing a rubber stopper in the pipe as suggested by Veihmeyer.*

In addition to the above advocated improvements the equipment could be refined so as to secure more speed, mobility and efficiency of operation. The engine should be rigidly fastened to a low springless, rigid framed trailer. This eliminates spring action and lowers the boom so that it will pass under telephone wires without being lowered. Mechanical control and a hammer guide would increase efficiency and safety.

After the pipe is withdrawn the coring point is removed and the core allowed to slide into a trough having one closed end. An eaves trough does very well. The core may come out in sections of 6 to 24 in. in length. This is especially true if sand seams or shrinkage cracks

*Although the writer was only recently aware of the fact, the coring point used is very similar to the refinement of the King soil tube designed by F. J. Veihmeyer of California Agriculture Experiment Station, described in Soil Science, Feb., 1929, Vol. 27, p. 147–152.

†The hearty cooperation of K. R. Moulton, Maintenance Superintendent, Minnesota Highway District No. 9, C. K. Preus, Assistant Engineer, and W. W. Paine, Chief Machinist, made this point possible.

are present. If the core lodges it can be removed by unjointing the pipe at A (Fig. 1), and striking the coupling upon a board or pavement. This should be done with care so as to avoid breaking the core into small sections. If gravel causes the core to lodge it may be forced out with a rod.

The outer portion of the core will be affected by compaction. Diagram 3, and cross sections of cores 4, 5, and 6 (Fig. 3) show this compacted area. By cutting away one side of the core (Diagram 3), the character and distribution of ice layers becomes visible (Fig. 2). If the cut surface is allowed to dry and shatter or crumble the soil structure and soil fracturing surfaces become visible. This is particularly true if the cores are broken transversely and vertically (Fig. 3).

The soil cores may be preserved by two methods.*† The first method is to slide the soil core into a 2-in. cardboard or tin tube, place on end and seal the lower end, then pour enough paraffin into the tube to cover the core. After the paraffin has hardened the tube can be removed and the paraffin cut away from the flat surface of the core. Care should be used in removing the paraffin. A heated knife blade or wire will facilitate this removal. The voids and cracks show where the ice had formed; as the soil dries, these cracks become exaggerated and shrinkage cracks may also develop. (Cores 4, 5, 6, Fig. 2.) The above method is better suited to soils than soil materials, as the soil materials have a tendency to settle as thawing progresses (Core 1, Fig. 2), especially if allowed to stand vertically.

The second method consists in placing the tube in a horizontal position, adding paraffin to the bottom of tube to support soil core, placing end checks in tube as shown, then adding paraffin until it nearly reaches cut surface of soil core. (Diagrams 4 and 5.) After the soil has thawed, and before shrinkage cracks develop, a more penetrating paraffin or solidifying white liquid may be used to fill the voids left by the ice. If left exposed in freezing temperatures the ice will gradually evaporate without noticeable soil shrinking. After the voids have been filled, it may be possible to seal the surface with some transparent material such as water glass. The heavy paraffin used did fairly well, but it is probable some other liquid would give better results in filling the voids and sealing the cut surface. There was not sufficient time to refine the method to the point of greatest efficiency. However, enough cores were taken to learn that the principle of the method was practical.

F. B. Christlieb, Resident Engineer, and J. S. Stuurmans, of Minnesota Highway Department, rendered valuable assistance developing this method of preserving soil cores.

*†The methods used are practically the same as used by Slater, C. S., and Byers, H. G., January, 1931. A Laboratory Study of the Field Percolation Rates of Soils. U. S. Dept. Agr. Tech. Bul. 232, p. 6 and 7.

Purposes of Travel of Automobile Owners

In connection with a traffic survey in Wisconsin information was obtained on how much of the indicated mileage of automobiles was for pleasure purposes, and how much was for business purposes. It also was desired to get some idea of the travel and touring habits of Wisconsin motor-vehicle owners. The results are given in the April issue of Public Roads and it is believed that these are the first figures of the character ever assembled and published. The information was obtained from all automobile owners covered by the survey, but only about 40 per cent of the schedules were tabulated in making up Table I. The average total mileages in this sample vary somewhat from the average mileages of the whole survey, because in making up the comparatively small sample, any automobile going a most extraordinary mileage or for apparently extraordinary purposes was disregarded.

This tabulation indicates that practically 60 per cent of all automobile travel is for business purposes, and 40 per cent is for pleasure purposes. Also, that 35 per cent of Wisconsin automobile owners drove into adjacent states in 1930 while only 7.5 per cent went into adjacent and distant states both. About 43 per cent of all Wisconsin automobiles apparently entered some other state in 1930. It is interesting to note that the farmers did by far the lowest percentage of touring in other states, while, as might be expected, residents of Milwaukee city did the most. Only 25.1 per cent of the owners of motor vehicles residing in towns traveled in other states than Wisconsin; 67.2 per cent of the Milwaukee motor-vehicle owners toured in other states.

TABLE I.—PURPOSES OF TRAVEL OF 1,720 WISCONSIN AUTOMOBILE OWNERS IN 1930, WITH SOME INFORMATION AS TO THEIR TRAVEL IN OTHER COUNTIES AND STATES.[1]

Place of ownership	Reports tabulated	Average miles traveled			No. visiting other States			Average number of other counties visited	Average farthest number of miles away from home in Wisconsin
		Total	For business	For pleasure	Adjacent	Adjacent and distant	Total		
Towns	708	5,575	3,586	1,989	160	18	178	4.9	95
Per cent	....	....	64.3	35.7	22.6	2.5	25.1	...	...
Places up to 2,500	187	6,995	3,841	3,154	92	13	105	9.5	147
Per cent	....	....	54.9	45.1	49.2	7.0	56.2	...	...
Places 2,500 to 15,000	195	8,867	4,870	3,997	95	22	117	10.3	167
Per cent	....	....	54.9	45.1	48.7	11.3	60.0	...	...
Places 15,000 to 75,000	337	8,043	4,559	3,484	155	35	190	8.8	169
Per cent	....	....	56.7	43.3	46.0	10.4	56.4	...	...
Milwaukee	293	9,567	6,017	3,550	156	41	197	11.4	185
Per cent	....	....	62.9	37.1	53.2	14.0	67.2	...	...
Total for State	1,720	7,266	4,364	2,902	608	129	737	7.9	139
Per cent	....	....	60.1	39.9	35.3	7.5	42.8	...	...

In order to get some idea of how many counties in Wisconsin the owners visited, that information was also taken. The average motorist visited about eight counties other than his home county. Again, the farmers did by far the least traveling in other counties.

The owner's statement of the greatest number of miles which the automobile traveled in Wisconsin away from its home garage was also recorded. The average touring limit was apparently 139 miles. Again, the farmers did far less touring than any other class, and again Milwaukee showed the larger wanderlust.

The table indicates quite clearly that the residents of Wisconsin did not travel as extensively in 1930 as has been believed to be the custom. Only 7.5 per cent, apparently, went on real tours into other states. The percentage visiting adjacent states is, of course, high. It would probably be much higher in the average state, for Wisconsin has Lake Michigan on the east, the Mississippi and St. Croix Rivers largely bound it on the west, and Lake Superior also interferes with contacts with Canada.

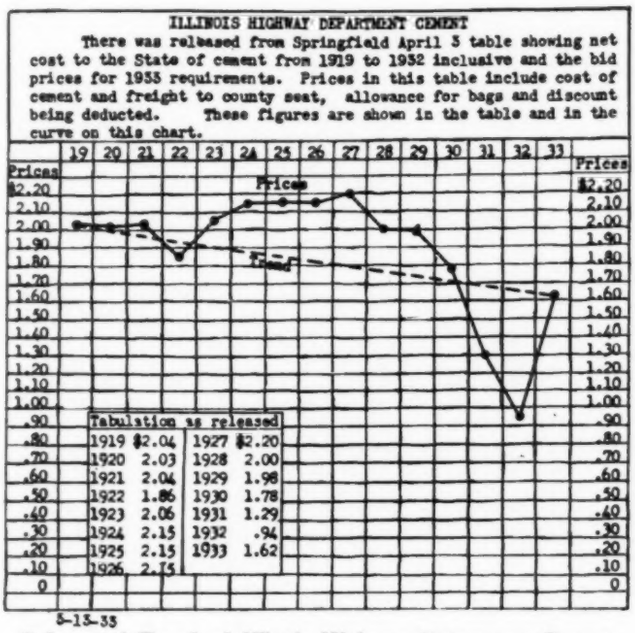
The percentage of the travel for business and for pleasure was ascertained from the original traffic survey sheets. The purposes of travel were so divided on these sheets that it was possible to distinguish the travel as between pleasure and business travel.

[1]This is a tabulation of 40 per cent of all reports of travel made in the survey. The same percentage of reports from each group of units of Government was used to produce a properly balanced sample.

EDITORIALS

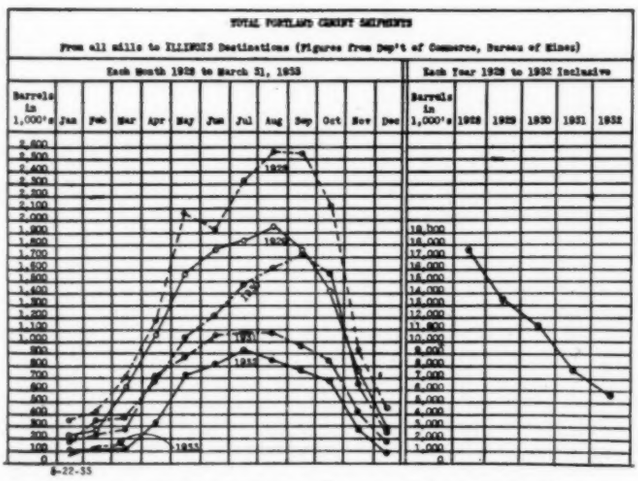
Will Portland Cement Prices Rise?

THE accompanying charts tell a story of shrinkage in cement shipments and in prices in Illinois. The trend of cement prices since 1919 has resulted in a 20 per cent decrease if the recent bids of $1.60 per barrel be taken as a criterion of what 1933 prices will probably average. However, if President Roosevelt's efforts to raise the general level of prices should prove successful, then cement prices will probably rise above the $1.60 mark.


ILLINOIS HIGHWAY DEPARTMENT CEMENT
There was released from Springfield April 3 table showing net cost to the State of cement from 1919 to 1932 inclusive and the bid prices for 1933 requirements. Prices in this table include cost of cement and freight to county seat, allowance for bags and discount being deducted. These figures are shown in the table and in the curve on this chart.
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
Prices
Prices
Trend
Tabulation as released
1919 $2.04
1920 2.03
1921 2.04
1922 1.86
1923 2.06
1924 2.15
1925 2.15
1926 2.15
1927 $2.20
1928 2.00
1929 1.98
1930 1.78
1931 1.29
1932 .94
1933 1.62
5-15-33

Prices and Trend of Illinois Highway Department Cement

Stock market speculators are convinced that President Roosevelt's inflation measures will raise both commodity prices and wages, for they are backing their opinions by bidding up the prices of securities. Just as the Wall


TOTAL PORTLAND CEMENT SHIPMENTS
From all mills to ILLINOIS Destinations (Figures from Dep't of Commerce, Bureau of Mines)
Each Month 1928 to March 31, 1933
Each Year 1928 to 1932 Inclusive
Barrels in 1,000's
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1928
1929
1930
1931
1932
6-22-33

Shipment of Portland Cement to Illinois Destinations

Street slump in 1929 forecast a decline in commodity prices, so the present boom in the same market evidently forecasts a further rise in commodity prices. Our own belief is that the average price and wage levels of 1929 will return, and that the rate of return will be more rapid than that after any great depression of previous years, such as the depression that started in 1893 and ended in 1898 by a return to normal. In addition to the economic forces that ordinarily led to a return to "normalcy," we now see the federal government about to engage in deliberately inflating both currency and credit. If the mere announcement of such an inflationary policy has served to send up prices to a marked extent, what will be the effect of actual inflation?

The state of Illinois has twice rejected bids of $1.60 for cement. Apparently certain state officials believe that there is no such law as that of supply and demand, and no such economic factor as currency inflation. It is not unlikely that the next bids on cement will exceed the last bids. Let's hope so if we hope for speedy return to predepression wages and business activity.

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Henry Ford on Railway Regulation

ABOUT 40 years ago the federal government began the regulation of railways, and about a dozen years later drastic regulation of their rates of charge for transportation was begun. Now after all these years of regulation by commission, the fingers of one hand serve to enumerate all the railway companies that are prosperous. Yet in spite of this record there are owners of highway common carrier trucks and buses who favor similar regulation of their business by the government. In order to escape competition they are willing to be put in a federal straitjacket that will as surely bring ruin upon them as it has upon the railways.

We suggest that they read the chapter on Railroads in Henry Ford's "My Life and Work." In that chapter Ford tells how he greatly reduced operating expenses on the railway that he had bought, until he was able to reduce freight rates with the object of attracting more traffic. But the Interstate Commerce Commission would not permit him to put the proposed lower rates into effect because it would upset the entire rate system of the middle and eastern states. One can well imagine Ford's disgust with such a system of rate regulation. He closed that chapter with these words:

"We found that on the Detroit, Toledo and Ironton we could, following our universal policy, reduce our rates and get more business. We made some cuts, but the Interstate Commerce Commission refused to allow them! Under such conditions why discuss the railroads as a business? Or as a service?"

It is now proposed to "coordinate" all forms of transportation by means of commission regulation. If there is any merit in competition as a spur to progress, such "coordination" should not be permitted.

Now just when competition is forcing the railways to make progress worthy of the name, federal politicians are urging restriction of competition. They propose to limit competition to "fair competition." We should like to know their criterion of "fairness."

The editor was chief engineer of the Washington Railroad Commission in 1906 and 1907, and at that time believed that public regulation of railways would be good not only for the public but for railway owners. It has turned out to be good for neither.

$400,000,000 *of Federal Money for Highways*

THE bill for "Industrial Recovery" appropriates $3,300,000,000 for public works and construction projects, of which $400,000,000 is allotted for "public highways and related projects." One of the most satisfactory features of this allotment for highway construction is that the amount apportioned to any state may be used to pay the entire cost of the work. In other words, a state is not required to match dollar for dollar with the federal appropriation, and in fact need not spend a cent of its own money in order to secure its share of the $400,000,000. This is indeed fortunate for those states whose legislators have inadequately provided funds for highway construction.

Highway improvements made under this federal act are not to be confined to the old federal aid system of main thoroughfares, but include "construction on secondary or feeder roads to be agreed upon by the State highway departments and the Secretary of Agriculture." It is provided that State highway departments shall submit projects to the Secretary of Agriculture; and it is evidently intended that construction shall be done by contractors under the direction of state highway departments, for: "All contracts . . . shall contain provisions establishing minimum rates of wages, to be determined by the State highway department." It is also provided that "no individual directly employed on any such project shall be permitted to work more than thirty hours in any one week."

In view of the great magnitude of this appropriation for road construction, it will be several months before construction will be in full swing. Contracts, both large and small, will probably be let every month during the rest of 1933.

Weather Cycles That Invert Their Phases

The editor recently read a paper having the above given title, in which it was shown that many rainfall cycles invert their phases periodically. There is a 2-year cycle that inverts its phase every 36 years; that is to say, for 36 years the years ending in 0, 2, 4, 6 and 8 tend to be the wetter ones of a sequent pair, and thereafter for 36 years the years ending in 1, 3, 5, 7 and 9 tend to be the wetter ones. This tendency is best seen in regions that have one rainy season, as in California. The reason why this tendency is not so evident in other regions is because, winter rainfall tends to be in phase opposite to summer rainfall, that is, a wet winter tends to be preceded and followed by a dry summer. Also spring and fall rainfall tend to be of opposite phase. This seasonal opposition of phase applies not only to the 2-year cycle but to many other cycles.

Another remarkable fact is that the amplitude of each cycle is slight at about the time that an inversion of phase occurs, and attains a maximum at the center of each phase period, e. g., at the center of the 36-year phase period of the 2-year cycle. Hence the 36-year period itself is a rain cycle. It had a great peak in 1878, and a smaller peak in 1915. It is probably the long known Bruckner cycle.

The 10-year cycle inverts its phase every 300 years, as shown in tree-rings and clay-varves. At present its peaks fall in years ending in 6 in California and Italy and other regions having a rainy season in the winter. There is very striking rain cycle of 300 years. A peak of the 300-year cycle is due in 1936.

There are at least a score of important rain cycles. Their large number is alone sufficient to obscure the existence of rain cycles. But add to this fact their periodic and sudden inversions of phase, their variable amplitude and the seasoned oppositions of phase, and you have more than sufficient reason why weather cycles have so long puzzled researchers.

Public and Private Indebtedness in Their Relation to the Depression

THE National Industrial Conference Board estimates American wealth to have been $362 billion in 1929 and $247 billion in 1932, the 32 per cent shrinkage being due to a decline in unit prices. Other authorities estimate the total indebtedness, public and private, as having been $300 billion in 1932, of which nearly two-thirds was in the form of mortgages, and the balance in the form of notes and accounts payable. This $300 billion debt is 83 per cent of the $362 billion wealth in 1929. When an individual's indebtedness reaches even 50 per cent of his assets, his financial condition is apt to be precarious. The same is true of most corporations. Yet the American people in 1929 had run up an indebtedness that exceeded 80 per cent of the value of their physical property! We need not look much farther for the main cause of the panic of 1929.

Public officials have been blamed greatly for the magnitude of bond issues in recent years. Hence it will surprise many readers to learn that in 1929 the total public net debt was not 8 per cent of the toal private debt. In round numbers the public debts in 1929 were:

Nation	$16.9 billion
States	2.3 billion
Counties	2.0 billion
Cities, towns, etc	13.0 billion
Total	$34.2 billion

These figures for national and state indebtedness are accurate. Those for counties and cities are approximate. In 1930 cities of 30,000 population had about 70 per cent of the total urban population and their total indebtedness was $10 billion. Since the per capita indebtedness of the larger cities averages considerably above that of the smaller cities and villages, it is not far from the facts to estimate total urban indebtedness at $13 billion in 1929.

Foreign governments owed America $11.6 billions, so that the national net debt was but little more than $5 in 1929. It is beside the point to say that this foreign debt may never be paid, for the point at issue is the American public indebtedness arising from living beyond the current income. If we deduct the $11.6 billion from the $34.2 billion, we have a total net debt of less than $23 billion, which is measures of the accumulated public expenditure in excess of current income up to 1929. Private accumulations of expenditures of analogous nature were 12 times as great. Yet many an editor has been attributing to extravagance in public affairs the financial debacle of the past three years. The same editors have been urging curtailment of public works, on the ground that public debt is already too burdensome to bear!

President Roosevelt is sound in his advocacy of a federal bond issue of more than $3 billion for public works and similar projects. This additional federal debt burden is insignificant compared with the good that will be accomplished by expending that great sum of money at a time when private enterprise languishes.

W. P. Gillette

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

Equipment and Plant for County Highway Maintenance

REALIZING that the problem of maintenance is as much different in the different localities as is construction and also that the laws and restrictions vary considerably, the County Committee on Maintenance of the American Road Builders' Association in the preparation of its report for the 1933 convention sent out a questionnaire to a number of county highway officials in which it was attempted to obtain a cross-section of this work throughout the country. The questionnaire attempted to secure information bearing on organization and systems used as these questions are important in arriving at any conclusions and recommendations on the subject of plant and equipment. The data assembled from the questionnaires showed a wide variation of systems and of plant and equipment in use but with certain fundamentals underlying practically all cases. In their report presented at the 1933 Convention of the American Road Builders' Association, the Committee of which H. G. Sours is Chairman, outlined and described some of the most important data obtained from this questionnaire. This was necessary not only as information but was required in order to draw conclusions which will be applicable to the various conditions under which the work is performed. The report of the Committee follows practically in full.

Division of Territory.—The plan which seems to be most generally used, where permitted by law, is a division into districts ranging from three to six in number which combines mileage with the different classes of work, taking into consideration the necessary facilities for convenience and centralization of operations in each district. This division is made according to the best judgment of the authorities in direct charge of maintenance work. Other counties are divided into districts by law with elected supervisors in charge of each district. Some counties make separate districts of each township or town and some few do not have any particular division of territory but operate the entire county as a district. The latter plan is usually followed where the county is small and where the work is more or less limited.

Organization.—Evidence of the extreme variation of conditions is reflected in the information obtained on organization. The degree of advancement of maintenance, the funds available, the nature of the work and the division of territory are all important contributing factors in the organization set-up. In the counties where maintenance work is well advanced and has been carried on along an extensive scale for some years, the organization in general is as follows:

An engineer in charge of the department who acts in the capacity of the general superintendent.

An assistant superintendent or general foreman.

Gang foreman in charge of each district.

A garage foreman.

Special gang foremen in charge of special classes of work.

A chief clerk in charge of office work.

Supplementing the above outlined skeleton organization, in some cases are patrolmen in charge of a few men or working as an individual in charge of a certain section of road.

The organization carried down the line from this point is made up of mechanics, truck drivers, tractor drivers, grader operators, blacksmiths, sign painters and other skilled help.

Stock room clerk, timekeepers and payroll clerks.

This in general, forms a most complete organization. From this point of high efficiency it is found that organizations dwindle on down to a bare skeleton of the above. In some cases where the work is limited, the organization consists of a superintendent and a number of patrolmen. Where the districts are created by law with an elected supervisor in charge, he is oftentimes more or less at liberty to perfect his own organization in his district. In some cases the work is being done in cooperation with the township officials.

Plant.—In nearly all cases a central garage and headquarters has been established. Where the volume of work is sufficient and the county is divided into districts, district garages and headquarters are maintained. This applies only where the districts are few and is not found to any extent where the districts are broken down to the size of the township. The completeness and the extent of operations of the district garages depends on the general set-up. In a few cases a very complete headquarters and plant is operated in each of the several districts. In other cases they consist principally of buildings for the housing of equipment and to provide a headquarters from which the district gangs operate. Usually they are located on a railroad siding equipped with unloading facilities and are provided with storage space for material. In a few of the well-equipped counties mechanics are kept at the district garages to take care of ordinary servicing of equipment either at the garage or emergency work in the field. In the majority of the counties the repair work at the district garages is limited and in practically all cases the general overhauling, painting, etc., is done at the central garage.

System of Operations.—In the majority of counties where the district plan is employed the gang system is used in the various districts. Some combine the gang and patrol system. As a general rule, special gangs which take care of certain classes of work such as surface treatment, crack filling, painting, bridge work and grading, operate over the entire county and this work is not handled by the district gang. In many cases the patrol system is used where the work requires only a few men or one individual in charge of a section of road. Under this plan the patrolman is usually equipped with

a small truck and the necessary small tools to handle the ordinary items of repair. In the case of traffic bound roads the patrolman is usually equipped with a motor grader or similar equipment and has assigned to him certain sections of road.

In most cases emergency work such as, snow removal, cindering of hills and intersections during sleet storms, heavy and damaging rains, is handled by placing the district foremen or patrolmen under standing orders to get out at any time, day or night, without waiting for orders from headquarters. Other counties handle emergency work, such as the above, by issuing the orders to the field men from the headquarters. In the case of a few counties it was found that trucks are rented for the season for snow plowing and that these trucks, located in the different districts are under orders to get out on the road when necessary.

Wages.—The majority of the counties have a uniform rate for the different classes of work with a few exceptions based on length of service and ability. A few counties base their rate on length of service and ability entirely in the different classes of work.

Cost System.—The majority of the counties use a system of keeping costs. A wide variation exists in the methods of handling this problem. Some states have laws which require a uniform system of accounting with forms prescribed, which enables a complete record to be kept and a comparison to be made with the costs in the various counties. Some are equipped with a system which permits the keeping of costs in various ways such as the cost of certain operations, the costs of certain classes of equipment and the combined costs of all the different operations per mile for the various types and sections of road. Other counties go still further and are able to show the exact status of their expenditures and the balances in each of the various funds at any time during the year. Some few counties keep a personnel record of all their employes with detailed information on each. This is a valuable system, especially at the present time where large numbers of men are being used on relief work.

Equipment.—The information collected shows quite a number of counties which are very well equipped enabling them to do practically any class of work required in their county. Others are more or less handicapped on account of not having sufficient equipment and a complete variety. Practically all counties seem to be pretty well supplied with grading equipment which is evidence that there is undoubtedly a considerable amount of force account construction work being done by the counties on low-cost roads. Trucks, which are very important on maintenance work, seem to be pretty generally supplied and in those counties where there is a considerable mileage of traffic bound roads the various types of maintainers make up an important part of the equipment. The data also show pneumatic tires are pretty generally used and that they are much more satisfactory especially on trucks, than the old solid-tired equipment. For surface maintenance one-man or power maintainers equipped with rubber tires are more in evidence than the crawler type.

There is quite a wide variation in the equipment in the central garages in different localities. The well-equipped garages are very complete in repair equipment such as any first-class commercial garage might have. In addition to this many of them are equipped with paint spraying outfits, sign shops, metal working equipment for top and body work and a carpenter shop. One county reported a very ingenious method of cleaning old equipment by using an old boiler charged with a soap solution which was sprayed onto the surface in the form of steam. This method completely cleaned all exposed parts and all classes of dirt as well as grease and left the surface to which the paint would adhere more readily than if cleaned off with gasoline.

Conclusions and Recommendations

Division of Territory.—Where permissible the district plan, which can be conveniently operated from the several headquarters, seems to be the ideal set-up. In every case a central headquarters and garage should be maintained where the majority of the overhauling and repair work can be done. The extent and nature of the work should govern the degree to which the district headquarters are developed.

Organization.—It is desirable to have an engineer in charge of the work. Where the volume of work is large and where the nature of the work requires the employment of considerable number of men, the gang system supplemented to a certain extent by patrols, is the most practical.

Special gangs to do certain classes of work and not assigned to any district will handle such work more efficiently than if each district gang is required to be trained along such special lines.

Where the nature of the work is such that only a few men are required the patrol system is the most practical.

A garage foreman, who is an expert mechanic, should be in charge of all repair work done in the central garage.

A stock room clerk should be made responsible for all parts and small tools such as are ordinarily kept in a stock room and he should keep a record of what is given to anyone who withdraws anything from the stock room.

A chief clerk should be in charge of office work supplemented with such additional help as is necessary depending upon the extent of the work which is done under the various systems of handling the office details.

Plant.—A central garage and headquarters is essential in every case where all overhauling and repair work of a general nature should be done.

Where the district plan is used, headquarters sufficient to house the equipment properly and railroad and storage facilities should be established.

This plan permits localizing of operations and avoids the necessity of dragging the equipment long distances to the central headquarters.

The repair work done at the district headquarters as a general rule, should be limited.

In a few cases where very complete district headquarters are maintained and the volume of the work sufficient to warrant it, it is convenient to maintain an organization in the district garage.

System of Operations.—Where the gang system is used each gang should be completely equipped to do surface repair work and shoulder and ditch maintenance. Special gangs operating over the entire county, must have the necessary equipment to do the special class of work assigned to each gang. Under the patrol system, each patrolman as a general rule should have a small truck and the necessary tools. The patrolman on traffic bound work should have a maintainer adapted to his particular job.

Emergency work such as snow removal, cindering or sanding during sleet storms, washouts, etc., should be handled by placing the district foreman or patrolman under standing orders to get out whenever required without waiting for orders from headquarters and to continue working until the emergency has passed.

Equipment.—Heavy grading equipment such as tractors and blade graders are desirable, particularly where shoulder widening and ditching is being done. This equipment can also be used in the construction of low-cost roads where grading is done by force account. Power maintainers or multiple blade drags pulled by a light tractor or truck are desirable for the surface maintenance of traffic bound roads. Patching equipment should consist of small concrete mixers and pneumatic paving breakers as the principal necessities, supplemented with the necessary trucks for hauling materials and also small tools. In general, the light fast trucks are more desirable for work in the gang system. Where a considerable amount of material is required on such work the medium sized trucks are more practical than either the extremely large or small trucks. In general, for all classes of hauling the medium sized faster trucks are more economical from the standpoint of investment and operation than the slow heavy truck. Pneumatic tired equipment is generally preferable to solid tires. Special work requires certain classes of equipment which is rather difficult to outline in a report due to the variation of the work. The garage should be equipped with a complete line of everything necessary for any class of overhauling. A paint spraying outfit is the logical equipment for painting. Equipment of all kinds should be cleaned and overhauled annually. The degree of overhauling will vary according to the condition. Truck drivers and power equipment operators should be made responsible for the greasing and condition of the equipment which they operate. Gang foremen should be made responsible in seeing that those responsible to him take the proper care of their particular piece of machinery. Insofar as possible there should be standardization of the different line of equipment.

Costs.—A comprehensive but simple system of costs should be kept on all classes of work. This is particularly true on equipment and plant so as to be able to determine the most economical and practical equipment to buy in the future and to compare the efficiency of the operators of equipment of the same class and doing the same kind of work.

In conclusion it might be said that facing reduced appropriations as practically all counties now are, it is essential that proper care be given to the available equipment in order that funds may be conserved. We hear considerable agitation against the use of equipment on road work and under present conditions there are some classes of work on which the use of machinery may be restricted without greatly increasing costs. If our funds for highway work are to be protected and saved from inroads being made on them for other purposes, it is essential that good judgment be exercised in the use of the equipment and that efficient operation of the entire organization be enforced so as to give the required service at minimum expenditures.

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PEDESTRIAN CONTROL TRAFFIC SIGNAL.—In an effort to reduce that large proportion of the city's fatal accidents in which the pedestrian is the victim, the Department of Public Works of Milwaukee, Wis., has developed a traffic signal which has a special indication for pedestrians. This "Walk" signal is white and goes on with the "Go" signal, but goes out when there is no longer time for the pedestrian to leave the curb and get across the street before the signal changes. The first installation was made at a school crossing. Later, similar signals will be installed at a more typical intersection, and reports made to the Institute of Traffic Engineers to compare this with other experimental work.

Cotton Fabric Reinforcement of Road Surfacing

The success achieved with test strips under service conditions of reinforcement of road surfacing with cotton fabric over a period of years in Southern States, notably South Carolina and Texas, led to the recent construction of a considerable section in one of Louisiana's main highways.

In this stretch of road extending for 2½ miles near Baton Rouge, cotton fabric constitutes a membrane between the layers of asphaltic surfacing. The application of fabric in this instance illustrates in a general way the

Unrolling the Cotton Fabric

employment of cotton in road construction. After preliminary preparation of the basic earth surface and the application of an asphaltic coating, fabric was laid while the coating still was sticky. An open weave fabric was used, weighing approximately 4½ ounces per square yard. Another asphaltic coating was applied over the fabric and the surface screenings spread to complete the job.

In this type of road construction the cotton fabric is stated to form in effect a waterproof blanket over the entire roadbed, acting as a binder, and giving additional resilience and strength to the top surface. Service tests are stated to have demonstrated that the fabric thus impregnated with asphaltic substance prevents the penetration of water beneath the surface of the road. Ravelling at the edges is also prevented. Furthermore, it is claimed, in case of a surface fracture caused by heavy impact, the fabric tends to hold the surfacing material together until the break is automatically "healed" by the rolling effect of traffic.

These advantages, according to the Cotton-Textile Institute, are not theoretical but have been proven in actual service. In South Carolina an experimental strip of "cotton road" laid six years ago and open during that period to daily traffic has occasioned a new minimum of maintenance expense and is still in excellent condition.

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NEW CHIEF ENGINEER OF INDIANA HIGHWAYS.—Merton R. Keefe, Lebanon, Ind., has been appointed chief engineer of the Indiana State Highway Department, in charge of all construction and maintenance. He was formerly connected with the Ulen Co. and had charge of many important construction operations.

Methods of Reconstructing OLD STEEL BRIDGES

By C. A. MELICK
Bridge Engineer, Michigan State Highway Department

SINCE by far the greater majority of our bridges consist of steel superstructures usually with timber floors, supported on a wide range of substructure types and materials, we will confine our discussion to this general type. It is usually a very simple and inexpensive matter to reconstruct so as to provide for carrying legal loading. It becomes a much more complicated problem to reconstruct to provide legal width in addition to legal strength. We will seldom encounter the desire to widen without at the same time providing for legal strength. However, the very extensive development in widening roadway shoulders as a relief for unskilled labor unemployment is emphasizing the inadequate widths and restrictions of our narrow bridges and unconsciously generating in the public mind an impression of safety which goes with wide highways, which is not warranted by facts, and undoubtedly the demand for widening old bridges will be very greatly increased in the near future.

Reconstruction problems can probably be best discussed by starting with the roadway wearing surface and following in order with the structural or load carrying part of the floor; then the structural system constituting the floor supports, which includes cross ties, stringers, and floor beams; then the structural members receiving the load from the floor system and carrying it to the substructure, which includes tension truss members, compression truss members, laterals, bracing, shoes, joint details and main girders; and finally the substructure itself which includes foundations, neat or body portions of piers and abutments, bridge seats and backwalls.

Roadway Wearing Surface.—The simplest and by far the most common roadway wearing surface consists of a single thickness of transverse plank which is usually about 3 in. thick and in widths of from 10 to 12 in., but commonly varies from 2 to 4 in. in thickness. The wearing surface in this case constitutes also the load carrying part of the floor. The load capacity of any timber depends on the species and grade of timber, the extreme loss of section from the wear it will receive from traffic before replacement, the extreme loss in strength from wet or dry rot or from moisture content or preservative treatment during its active service, the cross section of the timber, and the location and nature of supports. The standard of design for all timber bridge members is based upon the use of Douglas fir or Southern pine, each of dense structural grade, and since the safe strength of common local timbers is often not over half of the strength of these standard timbers and since there are no well established grading regulations applying to the selection of local timbers, it is evident that where local timbers are used they will generally require that supports be spaced much more closely together.

Even the best of timber is not too good for the severe requirements encountered in bridge reconstruction. A ¼ in. average wear in floor plank will decrease the capacity of a 2 in. plank 26 per cent, and of 3 in. plank 17 per cent, and this is not an unusual wear to be encountered in bridge wearing surface plank. It is wise, where wear is rapid, to use a separate course of plank for carrying the load in order to avoid this extreme loss. Creosote or moisture will slightly weaken timber. Rot may completely dissipate the strength of the timber although evidences of failure in wearing surfaces will usually be indicated in spots in advance of a general failure and thus serve as a notice of need of attention.

Single transverse plank should be as wide as practicable but not so wide as to warp or split easily. Ten inches is the commonest and probably the best width although 12 in. widths are sometimes found. Since no plank can help an adjacent plank carry its load, the wider the plank the greater the floor capacity, subject to split and warp changing this effective width, and plank narrower than 10 in. should not be used. Assuming 10 in. widths in the best grade of flooring and 10 per cent for wear and a 50 per cent overstress for the occasional maximum legal loads and for plank free from wet or dry rot, we may safely say that stringers should not be spaced in excess of 11 in., 1 ft. 1 in., 1 ft. 7 in., 1ft. 9 in., 2 ft. 6 in., 2 ft. 9 in., 5 ft. 3 in. and 5 ft. 8 in. for plank having actual thicknesses of 1¾ in., 2 in., 2¾ in., 3 in., 3¾ in., 4 in., 5¾ in. and 6 in. respectively.

If, therefore, you find your floor plank in good condition and of dense, strong material, you have merely to note your stringer spacing to decide whether your floor plank is limiting the capacity of the structure. If this should be the case, you can either (1) Use stronger material if securable, (2) Replace the plank, especially if in poor condition, with new and thicker plank, (3) Add an additional top surfacing of 2 in. longitudinal plank, (4) Provide some other type of stronger flooring, or (5) Provide additional stringers so as to decrease the spacing to enable the plank to carry legal loading. If the existing plank is old and/or in poor condition, replacement with heavier plank is by far the most economical and this will be of wide application to your township bridges on light traffic roads.

If your plank, however, is in good condition, it would be folly to waste it and the cheapest and simplest expedient is to place on top of it an additional layer of 2 in. untreated longitudinal plank. This has the effect of distributing a wheel load over two or more transverse plank instead of one. Assuming a distribution over two planks, the allowable stringer spacing for double thickness floors of high grade materials of this type for legal capacity floors may be 1 ft. 4½ in., 1 ft. 7½ in., 2 ft. 8 in., 3 ft. 1 in., 4 ft. 7 in. and 5 ft. 1 in. for base plank thicknesses of 1¾ in., 2 in., 2¾ in., 3 in., 3¾ in. and 4 in. respectively. A 2-layer floor has, however, an element of great and unsuspected danger. Its capacity and condition will be judged by the surface plank, which has no appreciable value in case the base plank should be rotted. For this reason, it is necessary that the base plank be pressure treated with creosote or with some other satisfactory preservative. A dip or brush coat is of but little value for this purpose. Likewise, if an existing untreated plank surface is being retained, it should be taken up and relaid on top of the new creosoted base plank.

Stringer Spacing and Capacity.—When stringer spacings are quite wide, say up to 5 ft., it will be found most satisfactory to use, instead of the creosoted base plank, creosoted cross ties 6 in. by 6 in. spaced 16 in. centers. This construction has almost identically the same amount of material as if 3 in. base plank had been used but provides perfect under drainage and ventilation and much greater durability due to the larger cross section of the tie and its increased ability to receive fastenings and countersinks. It usually has the disadvantage of a 3 in. greater boost in the roadway grade which, for paved highways, is objectionable but for township bridges would seldom be of consequence. In those cases when the use of additional stringers at a closer spacing is contemplated, decision will usually be based upon whether or not the existing floor is in such condition that it is to be removed and scrapped. If it is to be removed, it is, of course, a very simple matter to add a few additional lines of stringers and respace the old ones, once the old floor is removed. If investigation discloses the fact that the stringers themselves are of inadequate capacity, it may be possible by providing additional lines of stringers to secure legal capacity of both stringer and floor.

It is, therefore, essential that we now consider the capacity of our stringers. For either single transverse plank floors or longitudinal plank on transverse plank on cross ties, supported on steel stringers, the stringer spacing in inches required to carry legal loading, with unit stresses 50 per cent greater than design units and with a 10 per cent allowance for flange corrosion, may, with sufficient accuracy for panel lengths from 10 to 18 ft. covering practically all of our old truss bridges, be taken as 3½ times the depth of the stringer in inches, times the weight per foot of stringer in pounds, divided by the panel length in feet. On practically all of these old bridges either 5 in. I-beam or 6 in. I-beam stringers were used and it may be noted that for 5 in. I's the spacings for 10, 11, 12, 13, 14 and 15 ft. panel lengths must not exceed 17½, 15½, 14½, 13, 12 and 11½ in. respectively and are too shallow for safe use in panel lengths over 12 ft. Correspondingly, for 6 in. I's the spacings for 10, 11, 12, 13, 14, 15 and 16 ft. panel lengths must not exceed 24 in., 22 in., 20 in., 18½ in., 17 in., 16 in. and 15 in. respectively and should not be used for panels longer than 15 ft. In case timber stringers are used, 3 by 10 in. timbers may be spaced at 7 in. and 6.3 in. for 10 and 11 ft. panel lengths respectively; 3 by 12 timbers may be spaced 12 in., 11 in., 10 in., 9.3 in., 8.7 in. and 8 in. for panel lengths of 10, 11, 12, 13, 14 and 15 ft. respectively, and 3 by 14 timbers may be spaced 16.4, 15.0, 13.6, 12.6, 11.8, 11.0 and 10.4 for panel lengths of 10, 11, 12, 13, 14, 15 and 16 ft. respectively.

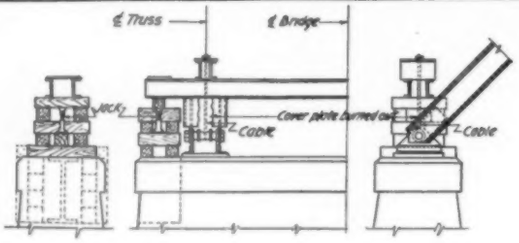
Increasing Stringer Capacity.—These data will enable you to quickly decide whether you should provide closer stringer spacing and thus strengthen both floor and stringer system. It is very commonly found that the floor is both of adequate strength and in good condition and that some other method of increasing stringer capacity, which would not necessitate taking up a perfectly good floor, is desirable. This can nearly always be accomplished by placing at mid panel points an additional transverse floor beam immediately under the old stringers and framing this floor beam into longitudinal stringers just inside of the trusses such a distance as will permit framing them into the regular floor beams with top flanges flush with the tops of the old floor beams and with end connection angles just clearing the hangers suspending the floor beams from the trusses. This detail usually works out as well for rivetted floor beam connections as for the more common cases where the floor beams are suspended from the truss pins by U hangers.

Strengthening Floor Beams.—We may now raise the question as to what should be done in case the floor beams should be found inadequate. While grossly inadequate floors and grossly inadequate stringers are very common, inadequate floor beams are relatively rare. This is due to the fact that but few of these old bridges are wider than 16 ft. inside of trusses and, therefore, do not permit two lanes of heavy trucks to pass. The legal width of a truck with load is 8 ft. 6 in. and the worst loading our floor beam gets results when the load travels centered on a line 1.5 ft. off and parallel to the center of the highway. For the general case of a 16 ft. clear roadway and about 17 ft. center to center of trusses, the adequacy of floor beams to carry legal loads may be closely determined by the rule that the depth of the floor beam in inches, multiplied by its weight per foot, must not be less than 172, 232, 295, 365, 432, 510, 570, 650, and 730 for panel lengths of 10, 11, 12, 13, 14, 15, 16, 17 and 18 ft. respectively. Floor beams are commonly 10 in., 12 in., 15 in. and 18 in. I's and corresponding factors of 250, 380, 630 and 990 respectively. It will readily be seen that 10 in. beams are inadequate for panel lengths exceeding 11 ft., 12 in. beams for panel lengths exceeding 13 ft., and 15 in. beams for panel lengths exceeding 16 ft. The approximate rule given will apply closely also for built-up floor beams.

If you should find the floor beams inadequate, you may either strengthen them by increasing their flange section by welding flange plates to the top and bottom flange or replace the light beams with new and heavier beams. This latter operation is not as difficult as it sounds; in fact, it is a simple operation. It should probably always be used whenever the first method requires taking up a floor which otherwise would have been left in place.

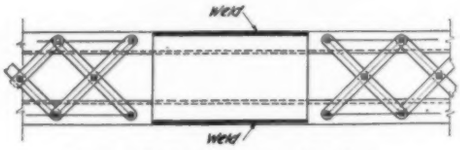
The most satisfactory method of welding flange plates to the floor beams requires that the plates should have widths such as to permit welding from above on flat horizontal surfaces and the top flange plates should, therefore, usually be ½ in. narrower than the beam flange and the bottom plates ½ in. wider than the beam flage, this in turn requiring that the top plates be thicker than the bottom ones. Also, while strength requirements do not require that the plates extend the entire length of the floor beam, the top plate must extend beyond the outside stringers to provide a uniform elevation for stringer rests. Welded work does not permit drawing as tightly together the parts to be welded as results from rivetted work and it is, therefore, highly desirable on exposed work that welds be continuous so as to completely seal against entrance of moisture and air between the plates and the beam flange. Whether a ¼ in. or a ⅜ in. bead weld should be used will depend on the size of the plate but a ¼ in. bead will quite generally be adequate. It is well to emphasize the importance of tack welding these plates to the floor beam flanges before undertaking any continuous bead. The tack welds will ordinarily be about 2 or 2½ in. long and should be spaced 12 to 18 in. apart. Only covered welding rod should be used to insure the least development of heat in the parts welded. Welding equipment should be at least 300 ampere capacity. No preheating of plates or shapes should be permitted on welded work.

The method of replacing a floor beam consists of placing a support under the stringers each side of the floor beam to be removed and bolting these supports temporarily to the bottom chord of the trusses each side of the pin or panel point. The old floor beam is then held in place by a cable at each

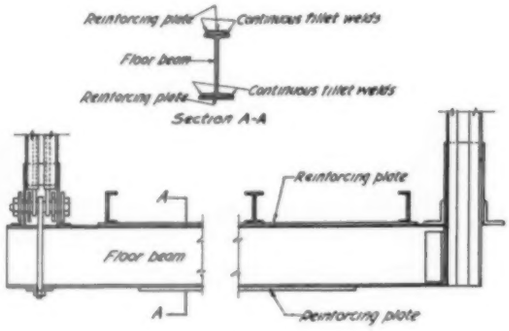


Raising Truss Shoes

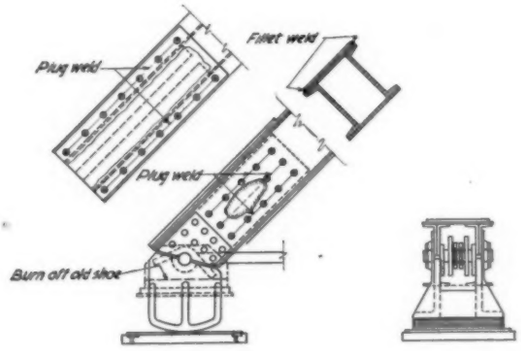
Repair Of Bent Eye Bar



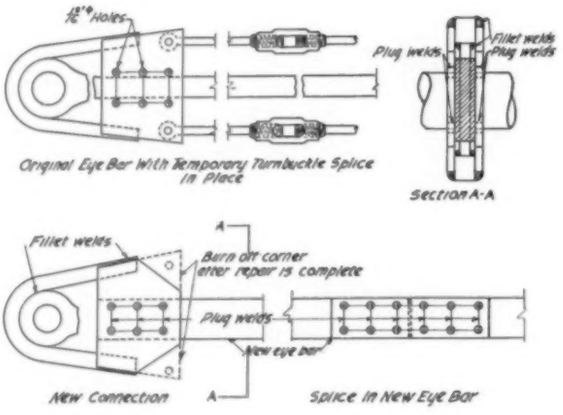
Repair Of Built Up Truss Member



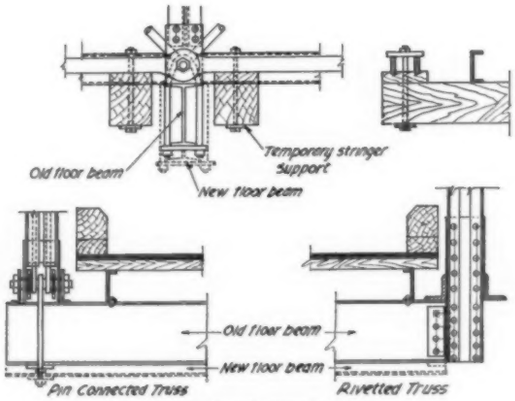
Reinforcing Floor Beam Flanges By Welding



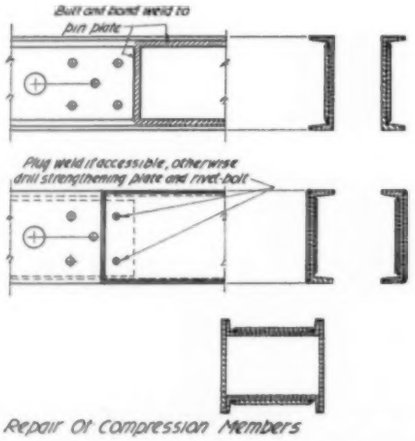
Repair Of Truss Shoes



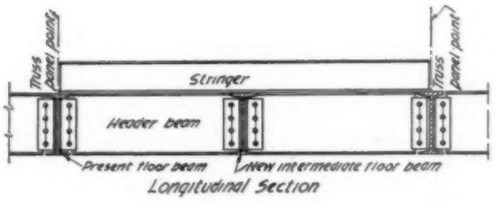
Strengthening Of Tension Members



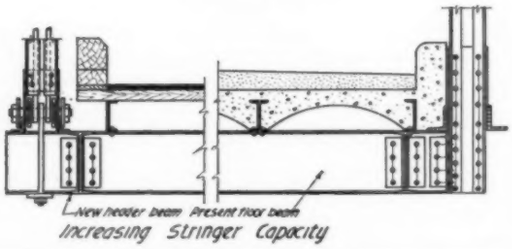
Replacement Of Floor Beams



Repair Of Compression Members



Longitudinal Section



Increasing Stringer Capacity

end while the U bolt hangers are removed, or in case of a rivetted connection, the old rivets are busted out. The old floor beam is now lowered from place and the new floor beam is placed in the reverse order of procedure. The U-hangers may or may not need to be replaced with heavier or longer hangers. Usually the wider flanges or greater depth of the new beams will require new hangers, in which case they should also have an excess of area over the old of at least 50 per cent. Pin packings will readily permit this increased area. Where rivetted connections exist, it may be desirable to ream out all old holes in the truss posts to permit the use of ⅛ in. larger rivets for increased safety. In this case, it will quite generally be desirable to use threadlock bolts to avoid the probability of getting a very unsatisfactory job of field rivetting.

Aside from the minimum and most economical methods of bringing a floor system of a bridge up to legal strength capacity as heretofore discussed, we are faced with the desire to secure in addition to strength, durability, smoothness, a finished appearance and freedom from continual maintenance. This usually means an additional wearing surface, a heavier floor type, or a more expensive design. Selection of type for these additional qualities will less likely be governed by cost than by the weight since the weight of the floor, while not of great consequence in designing the floor itself, materially affects the stringer and floor beam design and a heavy floor type will almost surely be barred by the limitation of the truss capacities.

Strengthening Truss Members.—It is, therefore, necessary that we now consider the truss capacities and the advisability of strengthening the truss members. But few examples of old trusses will be found which will not sustain a live load of 100 lb. per square foot of roadway at total unit stresses corresponding to 16,000 lb. per square inch on tension members in good condition. Most of these bridges have 16 ft. roadways. Since for heavy highway loadings our statutes permit up to 8 ft. 6 in. over all widths of loaded vehicles and since these widths are ordinarily fully utilized and often exceeded, it is obvious that two lines of traffic heavy enough to threaten truss capacity can not use such a bridge at one time. However, these vehicles can travel on a line off from the centerline of the bridge so that two-thirds instead of one-half of its load will go to one truss. But one truss is designed to carry 800 lb. per foot and thus permits a truck loading averaging 1,200 lb. per lineal foot over the entire span. The so-called H-15 loading used for the design of our bridges is equivalent to 1,200 lb. per lineal foot for a 56 ft. span and decreases continually for spans in excess of 56 ft. and, therefore, such trusses should, without exceeding their design stresses, be adequate for spans up to 56 ft.

However, there is no reason why we should post a bridge for load limitation until the resulting total unit stresses exceed the design units by 50 per cent or more and, since the dead load constitutes an appreciable percentage of the total loading, this permits our 100 lb. per square foot to be safely increased considerably over 50 per cent, commonly running from 75 per cent to 100 per cent, or permitting a loading of from 175 to 200 lb. per square foot. For this reason, many of these old trusses of the longer spans are not only adequate for our modern design loads but are quite safe to widen out to 20 or 22 ft. roadways to take two lanes of traffic. Very seldom do we find an old truss with span exceeding 50 to 60 ft., which is inadequate if in fair condition, and seldom do we find a span in excess of 100 ft. which would not stand widening to a 2-lane width, the increase in dead load from the increased roadway being relatively light.

However, we must be very careful to use only the lightest of substantial floors for this purpose as any increase in floor weight per square foot of roadway may be very serious. Our H-15 loading for two lanes on a 22 ft. roadway averages 79, 66, and 60 lb. per square foot for 100, 150, and 200 ft. spans respectively and this readily explains the blunder so often made of ruining the capacity of a bridge by replacing a timber floor with a concrete floor, the increased weight more than wiping out the entire live load capacity the truss would otherwise have had. Bridge trusses are usually found to be fairly well designed and are, more than most any other type of construction, closely apportioned in all their parts to their design loads. Strengthening such structures, in the event a main chord member is found deficient, will usually mean strengthening all members and in the usual shorter spans encountered the cost of such work would be impractical and would be unsatisfactory and a poor investment when made, as compared to replacing the entire superstructure with deck rolled girder spans with concrete floors. Since these rolled girders may be used in spans up to 75 or 80 ft. with transverse spacings up to 5 ft. or more, consistent with an economical simple concrete slab span, such designs very nicely fill the gap up to the limiting span where these old trusses are generally found able to take care of our modern loadings safely.

Aside from repairing the effects of collision, ice, corrosion and abutment movements, it will seldom be found advisable to strengthen truss members in truss spans of less than 75 ft. and the floor system should then be brought up to either legal capacity or generally to that capacity as determined by the truss capacity, which will usually be found to be not far short of legal capacity.

For the same reason that short span trusses of less than 60 ft. may be found inadequate, so also may we expect to find the diagonals, counters, and posts in the central panels of longer trusses inadequate. In such cases, it will usually be worth while to strengthen such members. The most effective methods of strengthening such members will usually involve both flame cutting and welding, and in discussing these methods, we will also discuss repairs as well as strengthening.

Compression members of trusses are most easily repaired or strengthened. This is due to the fact that the maximum stresses consist of a combination of buckling flexure with axial compression and are, therefore, confined to only a few local points in the member, allowing a liberal margin for corrosion or excess stress in the other parts of the piece as contrasted with the tension member, which is quite uniformly stressed through its length, and to the further fact that a hole for bolts or rivets in such members, while serving to attach the strengthening parts, weakens the member itself. Most compression members consist of two channels or two channels and a cover plate. All stress is transmitted at panel points through the webs. The most efficient and simple strengthening consists of a plate bead welded its full length inside the flange fillets to form a neat, flat surface excluding moisture. The plates should fit within ¼ to ⅜ in. of the flange so as not to require an excessively heavy bead and thereby add to the welding cost and at the same time not be so small as to induce arcing across resulting when the welding stick can not be inserted into the very bottom of the gap. The ends of the plates should also be sealed with moisture by welding. If the strengthening plates extend to or a short distance beyond the pin plates (or gusset plates in case of rivetted construction) this will usually be adequate.

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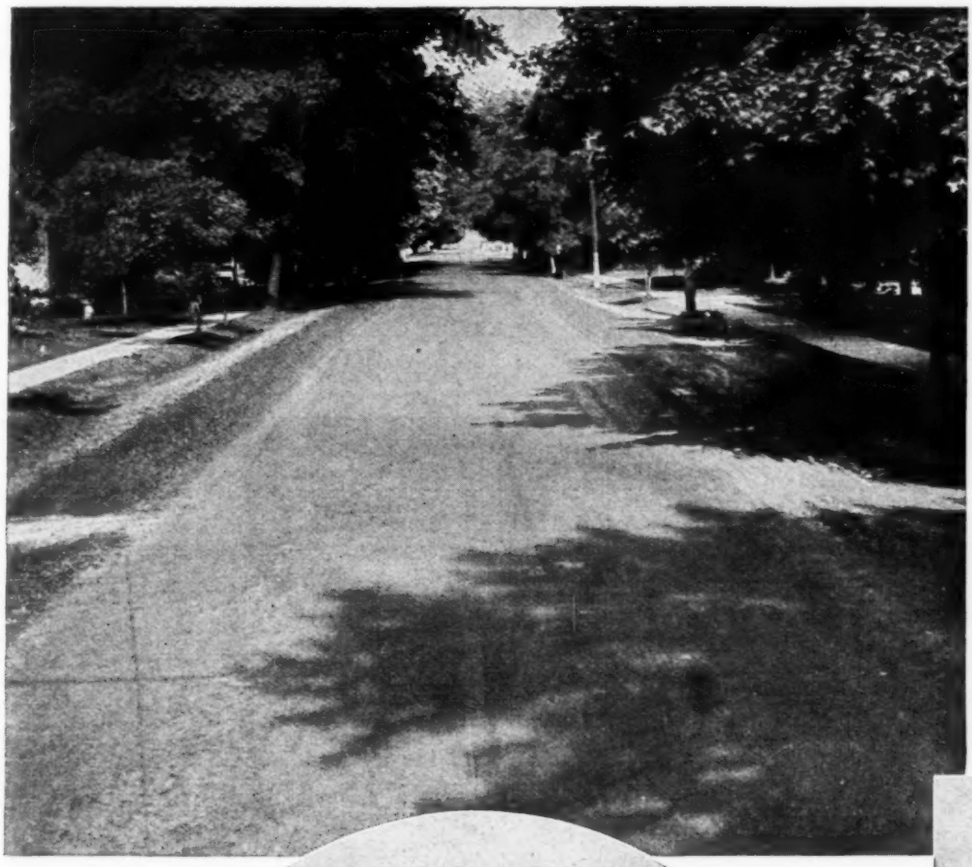

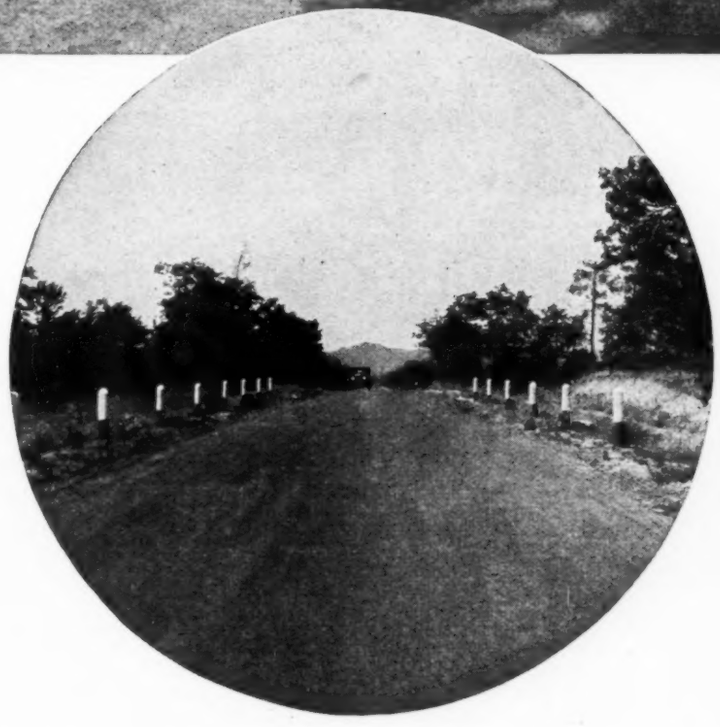

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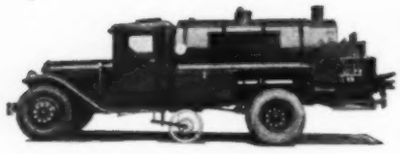
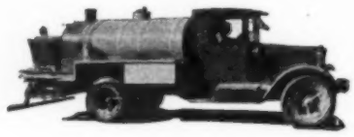
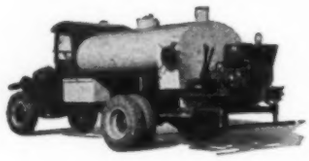

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When such plates would be interfered with by rivet heads, the rivets should, when practicable, be busted out and, after placing the splice plates, plug welds should replace the rivets.

If the channel legs face in so as to make the fillets inaccessible for welding, the reinforcing plates should be placed on the backs of the channels and should be ½ in. narrower than the channel to provide room for a ¼ in. bead. If the hole from a busted out rivet is on the inaccessible side of the splice plate, the splice plate should be drilled to match and a short rivet head and shank should be inserted from the far side so that the rivet shank just about reaches the far side of the splice plates and, while driven or held tightly in place, the hole in the splice plate should be plug welded. Where lacing bars and channel flanges have been badly bent, it is desirable to remove the bars and bead weld a plate in their place, using a plate not shorter than 1½ times its width. We often find the webs of end post channels completely rusted through near the roadway level, which is very close to the end shoes and is difficult of access for welding on account of cover plates, pin plates, and roadway floor. If the flanges are still in good condition and the corrosion does not extend too close to the pin, this condition is not serious as there is usually considerable excess area at these points. However, if this corrosion extends close to the pin, failure may result by the pin shearing through the rusted web. Under such conditions, the shoes will also likely be found in bad shape and the channel flanges none too good.

Repairing Truss Shoes.—It is our greatest neglect in bridge maintenance to allow dirt and water, and acids and debris of all sorts to collect around our bridge shoes, the small units which support the entire superstructure. The proper solution in this case is to have a new shoe made, either identical with the old or with better expansion provisions than was generally provided on old bridges. The webs and pin holes should be of the same size and spacing except that web thicknesses should be increased somewhat for future corrosion protection. The new shoe web should also be finished without the hinge plate finish, being sheared on a line ¼ in. below a diametrical line through the pin. When the truss is raised and suspended by cables around the end pin, the old shoe is burned off as near the pin as practicable and the remaining plates around the pin shoved aside and the truss is lowered onto the new shoe and a hinge collar is then set in place over the pin and plug or fillet welded to the web of the new shoe, depending on whether the shoe web fits inside of or outside of the end post web. Now, without disturbing the bottom end post lacing, burn out the entire lower part of the cover plate flush with the backs of the channels and to a height well above the corroded channel webs and slip in place the two short sections of splice channels after first drilling the old channel webs for plug welds, and when in place and clamped tightly with pin bearings in contact, proceed to plug weld. Now remove the cables suspending the shoe pins and place the cover splice plates shown, welding to the old cover plate by means of both plug and edge fillets. A hinge jaw plate should now be plug welded to the end post webs if the conditions of the old channels is such as not to be adequate for this service.

In the case of long posts of trusses, it will quite often be found that they are much more slender than modern design specifications require. This need not necessarily cause alarm, yet much money is being wasted by welding plates, angles, and channels to such members to increase their stiffness. Such members carry very light loads and failure of such members is almost unknown unless damaged by collision.

Strengthening Eye Bar Members.—Tension members and counters, consisting of eye bars and loop bars, either adjustable or of fixed length, require special consideration for either repair or strengthening. If these are buckled and bent, they should be straightened and brought back to take a dead load tension roughly in accord with their design dead loads. The most common case of this is the buckled bottom chord resulting from abutments crowding streamward an amount in excess of the truss expansion provided for. Here the abutment shoes must first be freed and arranged to slide easily and then the chord bars straightened and the truss action will do the rest. It is suggested that, in such cases, stiffeners be welded between eye bars at such spacings as may seem wise so as to enable the bottom chord to furnish greater resistance to abutment thrust in case the abutment continues to move. These stiffeners consist of staggered flats bead welded to top and bottom edges of eye bars as shown.

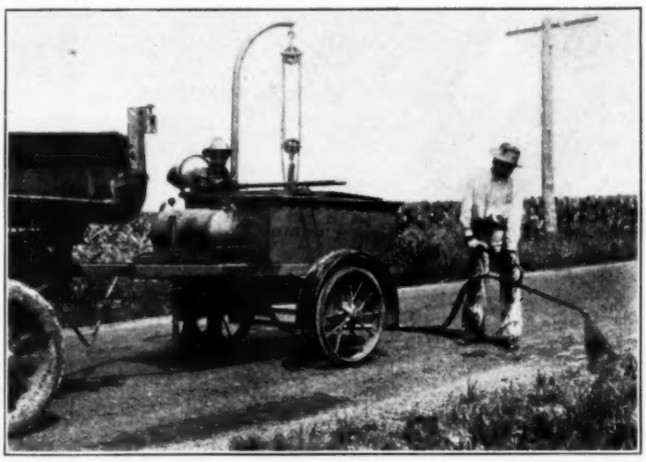
A very common mistake in strengthening eye bar members is to weld a flat on each side of the eye bar and extending as close as possible to the end pins. This is on the assumption that the apparently larger net areas at pins provide an excess of strength. This is obviously wrong as the excess area in the head of the eye bar is needed to offset the stresses in transmitting the load from the bar to the pin. A plan is suggested for either strengthening or repair of such members. U-shaped loop bars are actually bent to the diameter of the head of the eye bars and, after being tested for fit and placed in position, are then bead welded to two splice plates on the open ends of the U. Two temporary adjustable loop rods connecting the splice plates at each pin are then placed and an initial tension, approximately dead load stresses, applied and the effect on other tension members on the panel carefully observed. The original tension bars are then burned off close to the pin and at mid panel and removed. The new and larger bar is then inserted in two segments in each direction from mid panel and plug welded to the splice plates by means of large diameter plug holes in the end splice plates. With the ends of the new bars butting at mid panel, connecting splice plates are now similarly plug welded and the adjustable loop bars can then be removed.

Much money is sometimes expended in providing reinforcing for corroded members of a top lateral or portal system or to increase the stiffness of some members of such systems. Usually such money is practically wasted as the margin of safety on wind and lateral stresses is much larger and more uncertain than any other loadings. We must keep in mind that vibration, while undesirable and dangerous if excessive, is usually not associated with heavy stresses and is far less serious than is ordinarily assumed.

Raising Truss Shoes.—When repairs requiring the raising or supporting of a truss are required, it will be simplest, of course, to jack up the end floor beams if there are any and if they are or can be connected to the trusses adequately to take the load. Unfortunately but few of these old bridges have end floor beams. The simplest means of raising the bridge is then probably to burn out the lower part of the end post cover plates as already described and pass cables or U bolts around the shoe pin and attach to a bearing plate between two short, longitudinal beams which, in turn, would rest on jacks supported on transverse beams supported on cribbing on the bridge seat outside the truss shoes.

Widening Truss Bridge.—In case it is desired to widen an existing truss bridge, the bridge should first be rolled over until one truss comes to its final position.

Now is the Time!



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The old floor beams should then be replaced with the longer new floor beams in the manner already described. The new transverse lateral struts designed to be supported upon the top of the top chords, with the new laterals attached to them in place, may then be placed and permanently fastened to the top chord of the truss to be moved over. Meanwhile, the new bottom laterals attached to the new floor beams will also have been put in place. Tension rods with turnbuckles may be attached now to the ends of all new floor beams with the other ends connected to the trusses at the panel points. Blocks, bolted to the bottom side of the top lateral struts each side of the cover plate of the top chord of the truss to stay in position, may be adjusted in stages to permit 3 in. shifts at each panel point by tightening up on turnbuckles and/or by jacking and all panel points may be moved uniformly in 3 in. jumps until the new position of the truss is reached when the floor beam connections to the movable truss may be carefully adjusted and tightened and the top lateral struts at the fixed truss may be permanently connected. The new portal and sway bracing may now be placed and new stringers set. This procedure is inexpensive and requires no falsework.

Substructure Problems.—The time limitation for this paper now requires that we consider briefly substructure problems. Rubble, driven I-beam, concrete and steel caisson abutments are about equally common. Masonry and concrete abutments are nearly always finished with flaring sloping wingwalls on these old bridges; in my opinion, a serious mistake which many highway authorities are still perpetuating in their new structures. Piers are most commonly of caisson type. Two caissons may be adequately braced to each other and, at the same time, provide an adequate seat for widening of roadway by first burning a slot on diametrically opposite sides of the cylinders a few feet below the truss shoe bearings and then drilling through the concrete filling to permit entering through both caissons a heavy, wide, flanged, rolled beam which would cantilever outside of the old cylinders. After inserting the beams, the caissons may be drilled from the top, removing sufficient concrete to permit ready access for backfilling with new concrete, bonding and seating the new steel beams, and finishing neatly flush with the face of the cylinders and the new beam section.

Abutments of masonry or concrete with flared wings may be cut down a few feet below bridge seat and capped with heavy rolled steel beams, cantilevering in front of the flared wings, and these beams then encased with concrete to a depth of a few inches below the bottom flange of the beam, the encasement forming a new cope and bridge seat. Before encasing the beam, a shallow beam will usually be desired framing into the ends of the bridge seat beam and extending longitudinally to the flaring wings, which should be cut down to the new undercope elevation so that the encasement will also form a short triangular approach span supported in part on the wings and in part on the bridge seat beam.

Whenever we widen the roadway on the bridge, the shoulders of the road are also widened and we find that the wingwalls on the old abutments are usually too short to retain the fills at the same slopes in front of the abutments that formerly existed. To remedy this, a short, shallow wingwall may be built in line with the new railing and behind the old abutment with foundations in the old approach fills.

In case the old abutments have the wings cracked off from the body but are not otherwise seriously displaced, it may become desirable to furnish additional resistance to overturning by providing backstay anchorage into the approach fills. Too great haste should not be shown in this matter, however. It is perfectly natural for any abutment or wingwall to tend to lean away from the backfill a reasonable amount, and since these leanings are in different directions for the wing and body sections, there is a very strong tendency for the wings to crack away from the body, forming an opening which is widest at the top of the wall and tapers to nothing at the footings. This tendency is due to the fact that the soil pressure under the front of the footings is necessarily much greater than at the back of the footing, and, therefore, compresses more under the load and this in turn tilts the wall slightly.

For good soils, it is a very common experience to find that the abutments have moved in as much as ¾ in. at the tops of the walls and this corresponds, in general, to a soil compression of about ¼ in. under the toe of the footings. Cracks resulting from this cause generally will not open up further or vice versa. Such cracks should not be considered as serious defects or as requiring anchorage unless they exceed ¾ in. at the top and continue to open up. When anchorage becomes necessary, rods of about 1½ in. size are preferable and for each rod a face washer, having not less than about 100 sq. in. area, should be provided at the face of the wall. These rods may often be driven back into the fills from the face side of the wall after drilling the holes in the wall. For each rod there should be about 20 sq. ft. of dead man bearing area and the trenches burying the dead men should be carefully backfilled and well compacted and bearing faces should be against the compacted natural soil to as great an extent as practicable.

In all reconstruction and maintenance work, one of the most important features to provide for is drainage. If water runs away freely, it will generally do but little harm, but if it can collect at joints or in pockets, it is harmless only on the assumption that concrete is impervious, which we know is not the case. Even with the very best of concrete there will be places where it is not as dense as the mass of the work or where laitance or honeycomb is most likely to be formed and these places are usually found near joints and at the tops of horizontal surfaces, at the foot of high units of narrow cross section, in underwater concrete and around railing and pilaster details. Wherever water penetrates, it likewise freezes, this cycle being repeated until the concrete reverts to about its original gravel composition. On old work about all we are ordinarily warranted in doing is to provide weep holes through the abutments to drain the backfills and to make repairs with the aid of the cement gun, this type of repair when well done producing a concrete which is denser and more impervious than cast in place work.

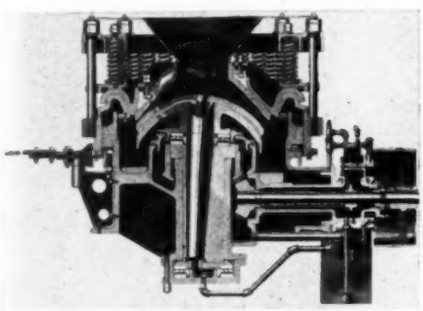
When the old abutments are not suitable for utilization in the reconstructed work, it is well to give consideration to the merits of a copper bearing steel sheet pile abutment driven immediately in front of the old abutment. Such abutments are economical, scour-proof, of adequate bearing capacity, not unsightly, durable, and can be readily constructed at any season of the year without the heating, housing, curing, pumping and other costs and delays which go with concrete work. The old abutments can be left in place, there is no excavation nor soft backfills and, by driving the sheeting outside of the old trusses first, this part of the abutments may be used to seat the new superstructures while removing the old trusses and completing the driving of the abutment sheeting. In this manner a temporary bridge and road is made unnecessary.

Acknowledgment.—The foregoing is an abstract of paper presented to the 1933 conferences on Highway Engineering at the University of Michigan.

New Equipment and Materials

A New Secondary Crusher

Smith Engineering Works, Milwaukee, Wis., announces another important development in secondary crushing practice—the Telsmith Gyrasphere, a spring relief crusher, roller thrust bearings and choke feed. Its heavy steel hopper and large, unobstructed feed opening permit the machine to take a free gravity flow. The crushing action is unique. All vertical thrust, constituting over half of the load, is taken on the massive end-thrust anti-friction bearings which are especially designed for the heaviest crushing duty. The horizontal crushing pressures transmitted to the eccentric bearings are reduced proportionately. Bell-mouthed eccentric sleeves



Telsmith Gyrasphere Crusher

are avoided; true shaft alignment is permanently maintained; gears are kept in perfect mesh.

Because of the spherical form of the head, the continuous flow of aggregate must follow an arc-shaped course, which multiplies the number of pinches it receives, thereby assuring a more cubical product with fewer slabs and splinters. Another exclusively Telsmith feature is the rotary head support. With the head supported on the eccentric with an anti-friction bearing between, all wear is taken by the roller bearing. Wear is uniform and perfect alignment of the shaft and eccentric is preserved.

Crushing members are of manganese steel. They wear evenly and maintain spherical shape throughout their life. The entire outer structure, including main frame, adjusting collar and concave bowl, is steel and guaranteed for two years against breakage even by tramp iron.

Inner and outer eccentric bearings are bronze sleeves, with automatic flood lubrication. The countershaft is also provided with anti-friction bearings of the tapered roller type and is automatically lubricated.

The Telsmith Gyrasphere is readily adjustable to meet a wide range of sizing requirements. Adjustments can be quickly and easily made even by unskilled labor, while crusher is operating. Adjusting mechanism is at convenient point on outside of machine. Springs are between adjusting and crushing members and protect adjusting screws against shock.

Springs are assembled in a self-contained unit protected by the feed hopper. Spring assembly is easily removable as a unit by merely loosening nuts on a few large tension bolts. Crusher may then be dismantled without loosening any other bolts.

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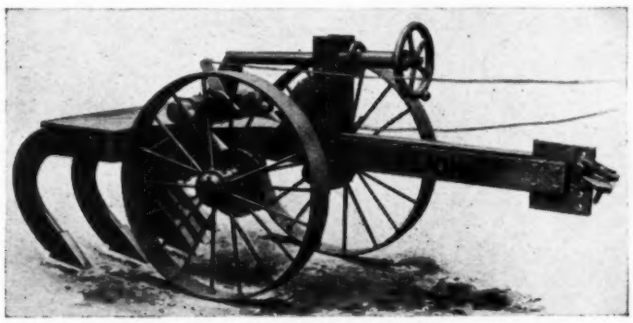
New Road Rooter

A new heavy duty rooter has been added to the line of the Galion Iron Works & Mfg. Co., Galion, O.

The rooter has exceptional strength due to its heavy plate frame which is all welded construction. The wheels, axle and standards are exceptionally heavy to withstand the severe shocks of working behind the largest tractors. The wheels are carried on Timken bearings. The tooth points are manganese steel castings and are reversible for self-sharpening. Any of the teeth can be removed to suit the power of the tractor, or, if working in rocky soil, to permit the passage of large rocks.



Galion Road Rooter

The rooter is adjustable to cut from 1 to 12 ins. deep. When cutting full depth the frame has a ground clearance of 12 ins. The drawbar is adjustable to conform with the drawbar of the tractor used and to increase or decrease the depth of the penetration of the points. The depth of the cut is adjusted from 1 to 12 ins. by means of a hand wheel.

The rooter is raised and lowered quickly and easily by two ropes extending to the tractor operator's position. One rope is attached to the lifting dogs which engage the wheels. By pulling this rope the teeth are lifted out of the ground by the wheels and locked in the raised position. The other rope operates a cam which unlocks and lets the teeth fall to the ground.

▼

Contractor's Wheelbarrow Platform Scale

A contractors bulk cement and wheelbarrow platform scale has been bought by the Best Scale Co., 1123 Adam St., Pittsburgh, Pa. This scale is an all-welded one-piece sturdy construction job with a platform size 38 in. by 40 in. The scale will handle a 1,200 lb. moving load concentrated on one end of the platform. The platform is supported by Stellite metal coated knife edges 1½ in. in length. The main bearings are of non-corrosive iron 1 9/16 in. in length are of the compensating and self-aligning type. The weigh beams are of non-corrosive cast alloy aluminum, and the poise is of the square type with center indicator and positive set screws.

Each beam box is equipped with plus and minus fan type dial indicator. The indicator moves a total distance of 8 in. and not less than 5/16 in. for each 2 lb. division. The dial face can also be moved ⅛ of the complete circle from center position so that the dial face is adjusted to face the scale operator. Changing the position of dial face does not in any way change the original balance of scale weigh beams.

The housing for the weigh beams is a sheet metal box rectangular in shape with storm proof removable front and back covers 16-gauge charcoal iron. Each box is designed and equipped so that it is a standard size for one, two, three or four beams, meeting state requirements. Standard size box insures the contractor that additional beams can be placed in or taken out of beam cupboard as required.

The main scale is built of open hearth structural steel and is 6¼ in. in depth. Each frame has a wheelbarrow ramp platform of ¼-in. steel plate, 11 in. wide, 14

Contractor's Wheelbarrow Platform Scale

in. long so attached to scale frame that it will fold over on platform for shipping purposes.

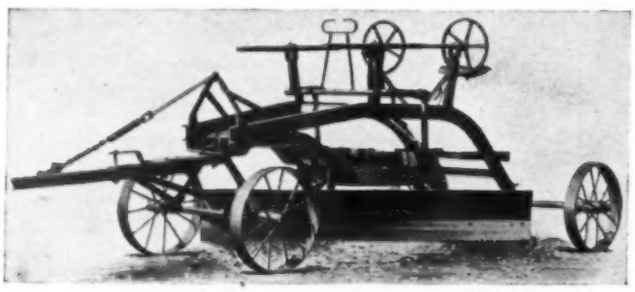
The beam box or cupboard is so arranged to fold down flat on scale platform in case scale is left on job for several days not in use or under watchman's care.

The whole scale is so designed that parts will not become dislodged in transporting from job to job, or by severe jars from placing a wheelbarrow or cement cart on platform. It also is so simple in construction that an ordinary intelligent person can take the scale completely apart and reassemble.

New Light Grader

A new light straight wheel grader for 2-horse operation has been brought out by The Galion Iron Works & Manufacturing Co., Galion, O. Although weighing only 1395 lbs. complete, it possesses exceptional strength and rigidity, due to thorough bracing and all-welded connections.

All necessary adjustments, such as raising the right or left hand side of moldboard independently; reversing the moldboard; sideshifting the moldboard and frame, and adjusting pitch and angle of moldboard, are easily made. The same high quality construction as used in the larger Galion graders will be found in the Galion "Pony." A 4-in. channel frame, weighing 6.25 lbs. per foot, and an extra strong moldboard assembly, well braced, combine to insure ample strength to withstand severe strain and shock. Strong steel wheels of 26-in. diameter mounted on 1½x7 in. plain bearings enclosed in dust proof hubs, make movement of the grader exceptionally easy.

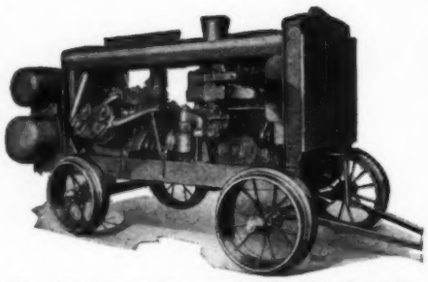


Galion "Pony" Grader

New Portable Compressor

A new portable air compress, which adapts the recognized advantages of two-stage stationary compressors and makes them usable in portable units, has been placed on the market by the Ingersoll-Rand Co., 11 Broadway, New York.

The compressor in the new machine is a 2-stage, air cooled unit. It has 2-low pressure cylinders, arranged in a V, and between them, in vertical position, a high-pressure cylinder. Partially compressed air from the low pressure cylinders passes through an intercooler. Cooling is effected by air drawn through the intercooler network by a fan. The intercooler efficiency is such that the air is discharged from it into the high-pressure cylinder at a temperature only a few degrees higher than the prevailing atmospheric temperature.



The 370 Ft. 2-Stage Air-Cooled Portable Compressor

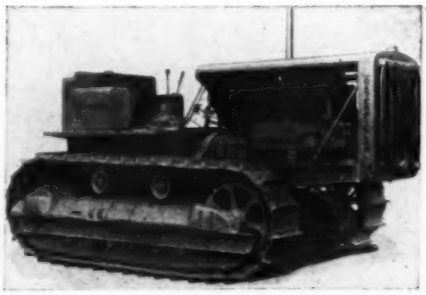
A Waukesha 4-cylinder gasoline engine of the heavy-duty type wtih patented "Full-Power" combustion chamber, designed expressly for this service, supplies the power. A clutch for easy starting is interposed between engine and compressor.

Improved regulation for the compressor is provided. Inlet valves play no part in this and are free to perform their primary functions. The speed of the machine is automatically reduced when unloaded.

The new two-stage, air-cooled portable is made in four sizes which have piston displacements of 125, 185, 250, and 370 cu. ft. per minute. It is obtainable in a variety of mountings.

"Caterpillar" Announces the Diesel Seventy-five Tractor

The largest and most powerful tractor in the "Caterpillar" line—the "Caterpillar" Diesel Seventy-Five—has just been announced by Caterpillar Tractor Co., of Peoria, Ill. This new tractor is powered with a 6-cylinder, valve-in-head "Caterpillar" Diesel engine developing 80 h.p. at the drawbar and 93 h.p. on the belt at 820 r.p.m. The engine has a bore and stroke of 5¼x8 ins. It has a 7-bearing, statically and dynamically balanced crankshaft, force feed lubrication to all crankshaft, connecting rod, wrist pin and rocker arm bearings, large capacity air cleaner and fuel filters and positive, simple starting by means of a Bendix driven by an auxiliary 2-cylinder gasoline engine mounted on the left side of the bloc.



Caterpillar Diesel Seventy-Five Tractor

Eight speeds—six forward and two reverse—are all controlled through a single gear shift lever, and provide working speeds ranging from 1.7 to 5 miles per hour. A "V" dash gives full visibility from the driver's seat and adjustable controls add to the ease and comfort of operation.

The machine weighs 30,550 lbs., and has a ground contact of 3,515 sq. ins. All transmission shafts are carried on heavy anti-friction bearings, steering is accomplished through dry plate clutches, each having 30 plates and a friction surface of 1980 sq. ins., extra heavy, heat-treated cast steel sprockets are employed and double idlers are held in position by cast steel yokes enclosing tandem recoil springs.

New Line Crescent Drag Scrapers

An announcement from Sauerman Bros., Inc., 488 S. Clinton St., Chicago, tells how the production of a new line of low-priced Crescent drag scrapers resulted from the combined efforts of the Sauerman engineering and production departments—the engineers contributing ideas for simplifying the design of the machines while the heads of the shop worked out various economies in manufacturing.

Small Sauerman Scraper Dragging Gravel from Bank to Crusher

This new "Utility" line of Crescent drag scrapers is claimed to be particularly suitable for use with the 1933 types of portable and semi-portable screening and crushing plants and for any light excavating that calls for moving materials any distance up to 500 ft.

There are five models of these "Utility" Crescent scrapers with buckets ranging in capacity from 9 to 40 cu. ft. and operating spans ranging from 100 to 500 ft. The complete unit includes a specially designed 2-speed power unit equipped with either a gasoline or electric motor or with a belt pulley. The hourly handling capacities of the respective sizes of scrapers when working on a 100-ft. haul, are as follows: 9 cu.

ft. scraper, 22 cu. yd. per hour; 13 cu. ft. scraper, 32 cu. yd. per hour; 20 cu. ft. scraper, 48 cu. yd. per hour; 26 cu. ft. scraper, 65 cu. yd. per hour; 40 cu. ft. scraper, 98 cu. yd. per hour. On longer hauls, the hourly capacity decreases in direct proportion to the distance the bucket has to travel to complete the cycle of operation.

Motor Controls Now Available on Adams No. 121 Grader

J. D. Adams Company, of Indianapolis, Ind., announces that Adams leaning wheel grader No. 121—a heavy-duty construction machine—is now available with power-operated controls. Power for the controls is supplied by a single-cylinder air-cooled gasoline engine securely mounted in the grader frame; the engine develops 6 h.p. which, it is claimed, furnishes ample power to make any adjustment or combination of adjustments at any time. Two or more adjustments can be made as quickly as one—operating efficiency is improved and time and money are saved.

Power is transmitted from the engine to a control box immediately in front of the operator; here a series of heat-treated gears, enclosed in a dirt-proof box and running on anti-friction bearings, transmits the power to the various control shafts. The control levers operate steel jaw clutches which release automatically when the extreme of any adjustment is reached.

There is an independent lever for each adjustment—vertical levers for vertical adjustments and horizontal levers for horizontal adjustments. Operation of the levers is easy to learn because the operator follows his natural inclinations and moves the levers in the direction in which the adjustment is desired. The vertical levers adjust the blade, scarifier and a special semi-circle tilting adjustment which is a feature on this machine. The horizontal levers shift the frame on the rear axle, turn the blade circle, shift the drawbar and blade sidewise, operate the steerable tongue and lean the front and rear wheels. All adjustments are made rapidly; the blade can be raised and lowered at a speed of almost 2 ins. per second.

The No. 121 is of all-welded, machine-finished construction, is furnished with 10, 12, or 14 ft. blade and with or without scarifier. It is of the high-lift type, being capable of high and steep bank cuts. An adjustment which permits tilting the front of the blade circle permits very sharp plowing positions to get the blade into hard ground; it provides also a ready means for the operator to adjust the pitch of his blade to get a free rolling action of the dirt in any kind of soil.

A new catalog describing this and other Adams leaning wheel graders may be had by addressing a request to J. D. Adams Company, Indianapolis, Ind., or any local distributor.

Automatic Air-Control Valve

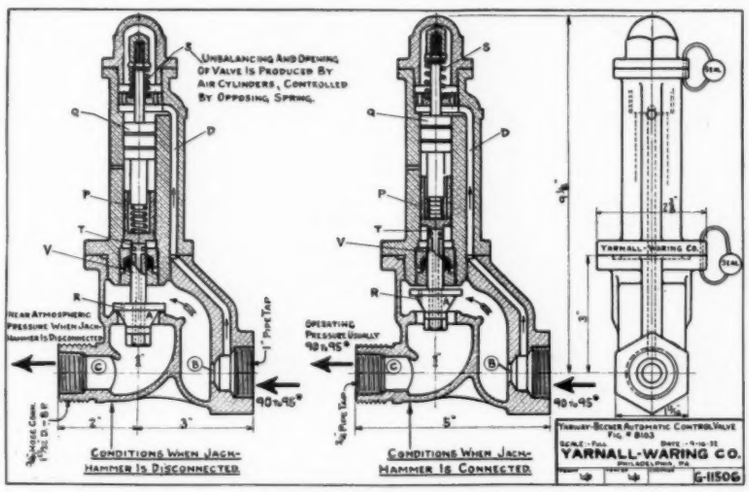
An automatic air-control valve, which permits definitely limited quantities of air to pass at various pressures, the quantity varying directly as the pressure, has been developed by the research department of the Jeddo-Highland Coal Co. Manufacturing rights have been sold to the Yarnall-Waring Co., of Philadelphia.

Designed to prevent waste of air in the operation of pneumatic jack-hammers in coal mines, the valve is stated to be equally effective for pneumatic tools in foundries and machine shops, for paving breakers working in congested sections where the whipping of a broken or disconnected hose is a serious hazard, for pneumatic riveters and for other work involving air pressure. With modifications it can be used in sectionalizing water lines.

The valve was described and demonstrated by Frank N. Becker, director of research of the Jeddo-Highland Coal Co., before the recent meeting of the coal division of the American Institute of Mining and Metallurgical Engineers at Hazleton, Pa.

The valve, placed near the end of the air line, consists of a globe valve body of unique design and a separate operating mechanism. These fasten together and are sealed to prevent tampering.

In the simplest form it consists of a piston in the operating housing, connected by means of a hollow valve rod to the valve disc. This disc is pierced by a 1/16-in. hole. The piston is held in its lower position by a spring and the line pressure, which is above the disc.


UNBALANCING AND OPENING OF VALVE IS PRODUCED BY AIR CYLINDERS, CONTROLLED BY OPPOSING SPRING.
NEAR ATMOSPHERIC PRESSURE WHEN JACK-HAMMER IS DISCONNECTED
OPERATING PRESSURE USUALLY 90 TO 95 LBS.
90 TO 95 LBS.
CONDITIONS WHEN JACK-HAMMER IS DISCONNECTED
CONDITIONS WHEN JACK-HAMMER IS CONNECTED
YARNALL-WARING CO.
G-11506

Automatic Air-Control Valve

The openings of the hollow valve stem are beyond the valve disc and into the cylinder below the piston. When the line below the valve is tight, pressure is established because of the air leak through the disc. When this pressure beyond the disc approximates that of the main line, the valve opens against the spring.

An orifice in the valve body on the incoming side causes a pressure drop through the valve, varying with volume. By spring adjustment the valve will close at any predetermined line pressure drop, corresponding to the volume flow. To compensate for variable line pressures, a second piston is employed to compress the spring in direct relationship to the line pressure. This spring receives its pressure from in front of the orifice and is not affected by the pressure drop through the valve.

In operation, the orifice is set for a given size tool and the springs adjusted to the flow for that tool. The valve is then sealed.

Before the miner connects his hose to the discharge end of the valve, the valve is automatically closed and when he has a tight line beyond the valve, because of the leakage through the disc, the pressure on the jack-hammer side of the valve builds up to the main line pressure, the valve automatically opens, permitting passage of just enough air to operate the tool. As soon as the tool is disconnected or when a pipe or hose breaks, thereby allowing free discharge of air with a consequent drop in pressure, the valve automatically closes. The operator is thus unable to waste compressed air.

New Machines for Pneumatic Application of Concrete

Production of a new extensive line of moderate priced machines for pneumatic application of cement, concrete and refractory materials is now in progress through the formation of a new company for manufacture of such apparatus by C. L. Dewey, widely known for his development of these processes and as associate in the invention of original cement guns. The new concern is The Gunitor Co., with sales office and factory at 1227 W. Beardsley Ave., Elkhart, Ind. With C. L. Dewey as president and general manager are associated W. McK. White, vice-president, and Sidney L. Dewey, secretary.

Several sizes of gunitors will be offered for immediate sale. All light in weight, low in price and with numerous mechanical improvements. Among innovations in the new line is an electric motor operated one-man model with electrical remote control; units including gasoline engine, air compressor and water pump, fully housed and mounted on steel chassis with rubber tired wheels.

Reduction of number of men necessary for application of materials is stated to be accomplished in the gunitors, aside from the one-man operated models; simplification of an improvement in design through extensive use of electric welding and metallic alloys, and increased portability through lightness, have been important considerations.

Distributor News

Pre Cote Moves Offices to Dallas

The Pre Cote Corporation has moved its offices from 708 Continental Bank Bldg., Indianapolis, Ind., to 318 Republic Bank Bldg., Dallas, Tex. Pre Cote Laboratories, including research and technical departments are retained in Indiana under the corporate title of Pre Cote Chemicals, Inc., located at 2917 Northwestern Ave., Indianapolis, Ind., K. E. McConnaughay, president, in charge.

Change of Name

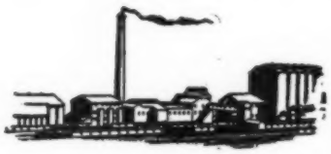
The Dow-Potter Co., Inc., Buffalo, N. Y., has changed its name to Dow & Co., Inc. The company maintains its office and warehouse at Court and Wilkerson Sts., Buffalo, and is exclusive distributors in the Rochester-Buffalo-Jamestown area of New York State for the following manufacturers: Walter Motor Truck Co., Carl H. Frink, Mfr., International Harvester Co. (Industrial Distributors), Rome Manufacturing Co., Ames Iron Works, Hanson Clutch and Machinery Co., Mohawk Asphalt Heater Co. The company also handles a full line of tractor equipment.

Neil C. Hurley Elected President Independent Pneumatic

Neil C. Hurley, brother of Edward N. Hurley, has been elected president of the Independent Pneumatic Tool Company, Chicago. He succeeds Ralph S. Cooper, who was named vice-president in charge of eastern operations of the firm with headquarters in New York. John A. McCormick was re-elected chairman of the board and Leonard S. Florsheim was named chairman of the executive committee. The directorate was reduced from eleven to seven, comprising in addition to Mr. Hurley, Mr. McCormick and Mr. Florsheim, Raymond J. Hurley, Dr. Walter McGuire, Walter Gatzert and Ralph S. Cooper. Frank B. Hamerly was elected vice-president in charge of the factory at Aurora, Ill., and Gordon H. McCrae, 40 Broadway, London, England, vice-president in charge of foreign business. F. W. Buchanan was named secretary and Edward G. Gustafson, treasurer.

G. G. Moran Goes to Mexico

G. G. Moran, who, for the past three years, has been in charge of sales promotion in the South and Central American territories for the FWD Export Department, left May 3 for Mexico where he will act as a special representative of the Four Wheel Drive Auto Co., Clintonville, Wis., during the next several months. While at the factory, in addition to his regular sales promotional work, Mr. Moran has edited the Spanish edition of the company house organ, the Saturday News Letter. This publication has been very well



received in the Spanish-speaking nations and will, no doubt, serve as a good introduction for its editor. Mr. Moran is a native of Mexico and has a wide personal knowledge of the automotive requirements in that country, having acted as a passenger car representative there for a number of years. In his connections with the export department he has been in close touch with conditions south of the Rio Grande and feels that the time is especially opportune for his trip.

Anderson Equipment Co. Opens at Omaha

Anderson Equipment Co. has been organized at Omaha by A. C. Anderson to handle a full line of contractors' equipment. For four years Mr. Anderson was connected with the Fuchs Equipment Co. and prior to that time was sales manager of the Brown-Bevis Co. of Los Angeles. Mr. Anderson has long been active in the Associated Equipment Distributors organization. The new company will handle National Equipment Co. shovels, cranes, pavers and mixers, Barnes Mfg. Co. pumps, W. A. Riddell Co. graders, Le Roi Co. engines and compressors, Independent Pneumatic Tool Co. air tools, Drake-Williams-Mount dragline buckets, Insley Mfg. Co. shovels, cranes and concrete handling equipment, Deming Co. pumps, Metal Forms Corp. road and street forms, The Hayward Co. clam shell and orange peel buckets, Macwhyte Co. cable, American Manganese Co. pumps, Atlas Powder Co. dynamite, Vulcan Iron Works pile drive equipment, Sasgen Derrick Co. winches and derricks, and in addition a full line of hardware and supplies. The office has been located at 616 Merchants National Bank Bldg., 13th and Farnam Sts., Omaha, Neb.

Brown-Bevis Co. Has New Organization

The Brown-Bevis Co., 4900 Santa Fe Ave., Los Angeles, Cal., one of the largest machinery houses in the West, handling general construction and road building machinery, and which company has been in receivership for nearly two years, was sold on May 10 to a new organization, consisting of Walter Parsons, formerly general manager of that company; J. A. Geynon, formerly secretary and treasurer of the Kimball Krogh Pump Company, Los Angeles; C M. Weinberg, president of the California Equipment Company, Los Angeles, and B. G. Rhodes. The Brown-Bevis Co. has been an important factor in the machinery business of southern California for many years. The business will be continued without interruption at the present location.

New Distributors for Iowa Manufacturing Co.

The Iowa Manufacturing Co., Cedar Rapids, Iowa, has appointed the following distributors in the United States: J. C. Corrigan Co., 179 Lincoln St., Boston, Mass., for Massachusetts and Rhode Island. J. Shuman Hower, 106 Foster Bldg., Utica, New York, for central New York. Charles S. Porter Supply Company, 424 Fourth Ave., Huntington, W. Va., for the state of West Virginia. Interstate Machinery Company of Omaha, Nebr., for all of Nebraska. Bublitz Machinery Company, 2139 Washington St., Kansas City, Mo., for western Missouri and Kansas. Henry D. Petter Supply Company, Paducah, Ky., for western Kentucky. Carolina Contractors Equipment & Supply Co., 824 Lady St., Columbia, S. C., for the state of South Carolina. Contractors Service, Inc., 317 W. Worthington Ave., Charlotte, N. C., for all of North Carolina.

Jensen and Ott Now Affiliated with Boehck Equipment Co.

"The Boehck Equipment Co., Milwaukee, Wis., announces that A. H. Jensen and A. S. Ott have affiliated themselves with the company in sales capacities. Mr. Jensen will continue covering the southern part of Wisconsin as well as a great share of Milwaukee, which he has covered for the past six years representing the Hunter Machinery Co. and where he is well known by the trade. Mr. Ott will cover the northern part of the state and a portion of Milwaukee county, which territory he has covered for the last three years while with the Hunter Machinery Co. Previous to this Mr. Ott was with the Chain Belt Co. for twelve years. The Boehck Equipment Company are distributors in Wisconsin for Barber-Greene Co., Byers Machine Co., Jaeger Machine Co., LeRoi-Rix compressors, Williams buckets, Huber Manufacturing Co., and several other well known lines.

G. S. C. Hi-Speed Spreader Now Handled by Syracuse Road Machinery Co.

The Syracuse Road Machinery Co., room 34, 201 E. Jefferson St., Syracuse, N. Y., has taken over the sale and manufacture of the G. S. C. Hi-Speed Spreader, according to a recent announcement by P. H. Miller, general manager of the new organization. Production has already begun on the new units, which have been greatly improved over earlier models, and prompt shipments are being made. The G. S. C. Hi-Speed spreader handles gravel, sand, cinders, crushed stone and calcium chloride.